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THE PORT OF ALEXANDRIA.

The Port of Alexandria is essentially a compound haven on a coastline unsuited in its natural state to the mooring of large ships close inshore owing to its sandy character and has been adapted to modern requirements by the provision of proper quays and protective breakwaters. The relatively small choice of havens suitable on the Mediterranean coast and the predominant reason of adjacency to the wealth of Egypt served to make the harbour of first-rate importance in the days of Ancient Greece. The port fell into decay and remained in this parlous state for many centuries, with a transient and artificial rejuvenation during the days of Napoleon's Egyptian activities. The growth of the modern port that Alexandria is, in fact, dates from little more than half-a-century ago when operations were begun in 1869 by Ismail and the commercial port placed under an international commission.

Alexandria comprises two sections and the lay-out viewed from the African mainland somewhat resembles in configuration a pair of spectacles of which the bridge is the Peninsula of Ras El Tin, located north-west by south-east, with the spacious Western Port on one side and the much smaller Eastern Port on the other.

The Peninsula is scooped out on the north-western and Mediterranean side by the symmetrical curve of Anfouchy Bay. The western extremity of the projecting land mass is marked by the Great Lighthouse of Ras El Tin constituting a postern of a northerly but rocky entrance to the Western Port. Turning back to the north-east, the coastline of the Peninsula extends southwards round Anfouchy Bay, bounded on the north-east by Fort Adda, located on an artificial mole. Proceeding eastwards the northern extremity of the Promenade Quay is encountered, with Fort Kait Bey forming the root of a short breakwater running due east and constituting the northern boundary of the Eastern Port.

The coastline of the latter, like that of the much smaller Anfouchy Bay is an elegant crescent with Fort Kait Bey at the north-west top and the other or south-east point overlooking the island port of Silsileh. At present the Eastern Port is open on the north side, but the breakwater projected to run due west of Fort Silsileh will remedy this and allow of an eastern entrance a few degrees south-east of the existing breakwater. The Eastern Port is shallow and is chiefly used by pleasure boats.

The Western Port is bounded on the east by the Peninsula, with the great Lighthouse of Ras El Tin forming its north-west and most seaward boundary mark. A short distance north-east of the lighthouse is the Royal Palace. Further east along the coastline is a quay of the Khedivial Mail, which forms the west side of the Arsenal Basin. The Careening Basin further south-east is bounded on the west by the spacious Arsenal Quays, whilst the mainland is distinguished by the lengthy Central Quay. At its western end is a small quay in front of the Customs, and then the locks of the Mahmoudieh Canal.

Offset to the north-west is the massive Mahmoudieh Quay. What is virtually a basin separates the latter from the great coaling quays which run out due north-west and then curve round southwards enclosing by a bow-like encirclement the northern end of the Coaling Basin. At the north and western extremity of the Coaling Quays is a lighthouse with a green light which is due south-east of the Great Lighthouse of Ras El Tin. The area to the west of the Coaling Quay forms the outer harbour.

Further west along the mainland are the Petrol Quays, Dry Dock, Wood Quays, Nitrate Quay and a Quarantine Quay. Beyond the latter, the quarantine breakwater runs out in a north-westerly direction and is marked at its extremity by a lighthouse giving a green light. This marks the southern side of the chief entrance to the main western port. It may be mentioned that there is a small protective breakwater quite near the shore running nearly parallel to the wood and nitrate quays.

On the north-west and seaward side of the Western Port is the Outer Breakwater, 3,500 metres in length. This runs north-north-east for two-thirds of its length and then dips eastwards almost linking up with the Great Lighthouse of Ras El Tin, and forming the north-western postern of the rocky entrance previously referred to. Away to the far west of the Outer Harbour and beyond the limits of the breakwater is Bel El Arab Bay with the Little Lighthouse du Mex in between.

Typical sections of the 1905-08 and 1913-17 breakwaters appear on the Supplement, whilst two earlier series, 1870-74 and 1905-08 are illustrated on another page.

PRIVATE WHARF DUES.

The respective merits of private harbours, quays and wharves and those of duly constituted authorities come under discussion from time to time. The following is a topical declaration from the shipping standpoint, which appeared in a recent circular issued by The Baltic and International Maritime Conference.

" If harbours with their facilities on the water and on shore are owned and controlled by the state, the municipality or some such body, private or public, in which is vested the right to charge certain dues for the use of the harbour, shipowners have as a rule no difficulty in ascertaining beforehand the exact amount of dues to be paid by their vessels, and at the same time there is a reasonable guarantee that the dues represent a suitable remuneration for the facilities offered when everything is taken into account.

" The difficulty begins when firms or persons not directly concerned in the activities of the harbour, acquire land situated within the territory of the harbour and thereon construct quays or wharves where they handle goods for their own account, or sometimes for other people. It is a natural desire on their part to recover some of their outlays to upkeep and possibly their rent, but it is not satisfactory for the owner who may have calculated only with the payment of official dues, to be debited with such charges."

The conference goes on to state that their organisation has received a number of complaints and enquiries in regard to this question and that in several cases the dues have clearly been an over-charge. The instance is cited of the quay dues charged the shipowner by a broker to cover the rent he had to pay for quay space on which receivers stacked their cargo; or of the quay dues debited by receivers at their own wharf in a port where no harbour or quay dues would otherwise have to be paid, no stipulation being inserted in the charter party to the effect that the cargo should be discharged at that particular wharf.

The circular discusses in particular the somewhat complex considerations involved in the water rights acquired by shippers in certain Finnish ports.

" These shippers are, apparently, fully entitled to levy dues, but whether their rights are sufficient to give the charges the character of official dues, is a question for the Finnish courts, but there can be no doubt that it is unreasonable for the shipowner who has fixed his vessel to load at one or more places within the same customs district to find that, in addition to the official harbour dues, he will be debited with harbour dues at each place by the shippers who own the water rights. This procedure is all the more unreasonable as the dues seem to be levied on the same basis as the official harbour dues, regardless of whether there are any or only the simplest facilities available for the mooring of the vessel."

The conference raises no objection to the owners of private harbours levying dues, as the vessel being expressly fixed to or from the harbour, the shipowner will know or be able to ascertain beforehand what dues will have to be paid. It does, however, point out that there is no proper guarantee as to whether the dues are rightly calculated so that they do not cover up-

keep of quay space or other outlays which, according to their nature, should appertain to the cargo.

In conclusion, the circular says that although the issue is not always a clear one, the amount of the dues charged by owners of private harbours, quays or wharves are sufficient to warrant a close investigation of the circumstances of each case before passing the account.

THE PORT OF WANGANUI.

The New Zealand Port of Wanganui consists of two harbours, a deep sea harbour for overseas ships, situate inside the Wanganui River near its mouth, approximately three-quarters of a mile from where the river empties itself into the sea, and a harbour for smaller craft, about four miles further up the river.

The entrance to the port is 600 ft. wide and protected on each side by moles, one 2,600 ft. long and the other 3,400 ft. long. Overseas vessels 475 ft. long can enter port, berth at the wharves and lie there in absolute safety whatever may be the conditions of the wind and the sea.

The port serves a large area of rich agricultural and pastoral lands comprising approximately 2,200 square miles with a population of about 50,000 people. It is the natural port for the district, bounded by Hamera, Tanmaranui and Palmerston North.

Minimum depths of water are as follows:—At entrance just outside moles, 24 ft. at H.W.O.S.T. and 21 ft. at H.W.O.N.T; between moles from the entrance to wharves, approximately ¾ mile, smooth water, 22 ft. at H.W.O.S.T., 19 ft. at H.W.O.N.T., and 20 ft. H.W.O.S.T., at berthage alongside wharves.

Length of quayage is approximately 4,250 ft., and there are large cargo sheds available for use on the wharves. The latter are all connected with the railway system and have a double set of rails laid thereon. A turning basin 40 acres in extent has been built and is to be dredged to a depth of 23 ft. at H.W.O.S.T.

THE CHIEF PORT OF SIAM.

Bangkok, the chief port of Siam, situated latitude north 13° 38 mins., longitude west, 100° 29 mins., is 25 miles from the mouth of the River Menam Chow Phya, on both sides of the river. The principal port of the town is on the right hand side of the river.

The Menam bar outside the mouth of the river is about four miles broad, and the principal channel is marked by two light vessels, the outer one showing a fixed red light and the inner one a fixed green light on their own port side about 100 yards off. At the mouth of the river there is another light vessel showing a fixed red light visible 5 miles. This light vessel has always to be passed to the northward at a distance of about 100 yards.

During 1913 the bar was re-surveyed by the Royal Siamese Navy and a very useful chart of the bar was published during the same year.

From the Regent Lighthouse on the Menam Bar signals are shown at day and night, indicating the depth of water on the shallowed part of the bar.

The south-west monsoon lasts from April to September. In this monsoon the highest high water is in the evening and varies at spring tides from 14 ft. 6 in. to 15 ft. 6 in. At the same time the lowest low water varies from 5 to 6 ft.

The north-west monsoon lasts from October to March. During this monsoon the highest high water is in the morning, and varies at spring tides from 15 ft. to 16 ft. 6 in. At the same period the lowest low water varies from 6 to 7 ft.

The Hydrographical Office (formerly the Harbour Department), publishes every year a little book giving high water and low water at the bar, and known as "The Bangkok Bar Tide Table." This booklet is compiled from observations taken at the Regent Lighthouse, with a self-registering tide gauge. The particulars given are very reliable, and all masters and pilots of this port follow the information given in the tables.

The Bangkok harbour is a section of the River Menam Chow Phya. It has a length of 10 miles, including the Siamese Man-of-War anchorage, which has a length of two miles. The breadth of the harbour varies from 500 to 1,800 ft. and the depth from 6 to 15 fathoms mid-stream.

With the exception of vessels alongside wharves, all vessels have to moor from the anchors in the middle of the harbour, one for ebb and one for flood tide, using from 30 to 45 fathoms on each chain. There are about 60 berths mid-stream for vessels from 200 to 350 ft. in length. The tide at times runs with a speed of up to three miles.

Many shipping houses and other firms and rice mills have wharves to accommodate deep-water vessels. In addition to the Royal Siamese Naval Dockyard there is a dock belonging to the Bangkok Dock Company, Ltd., which has an extreme length of 330 ft., a length on block of 330 ft., a width at entrance of 45 ft., with a depth of 11 ft. on sill.

The dock possesses a steam sheerlegs capable of lifting 25 tons, and two 2½-ton electric cranes on their wharf.

The same company has just built another large up-to-date dock, with an extreme length of 360 ft., length on blocks 350 ft., breadth 50 ft., height of sill above bottom of dock 4 ft. 6 in., depth of water on sill at H.W.O.S.T. 16 ft. 6 in.

The firm has also three slipways capable of slipping launches up to 65 ft., and sheerlegs capable of lifting 25 tons. Ships up to 250 ft. long of steel or wood can be constructed, and all kinds of ship and machinery repairs are done. Its iron and brass foundry is capable of turning out castings up to 10 tons, and its machine, boiler and blacksmith's shop are fitted out with up-to-date machinery.

The United Engineers has two slipways capable of slipping vessels up to 250 tons, and also a general repair shop. There are also three Chinese docks which can dock vessels up to 180 ft. in length. About twenty repairing shops undertake the repair of launches and smaller local craft. The foreign trade of Bangkok involves about 750 steamers with a net tonnage of about 800,000 tons per year.

KIEL CANAL TRAFFIC.

A report received by the Department of Overseas Trade from His Majesty's Consul-General at Hamburg states that, compared with the preceding month, there was a seasonal decline of some 600 vessels and 150,000 tons traffic through the Kiel Canal in September, but in comparison with the figures for September, 1926, there was practically no change. The actual returns were as follows:—

	No. of Vessels.	Net. Reg. Tons.
September, 1927	4,717	2,050,472
August, 1927	5,307	2,194,293
September, 1926	4,803	2,057,503

Of the 4,717 vessels in September, 2,476 were registered as sea-going steamers and aggregated 1,857,224 net reg. tons, while 42 vessels aggregating 35,992 net reg. tons were sea-going motor ships. These included 2,292 freight and passenger steamers aggregating 1,839,596 tons, two fishing steamers of 182 tons and 123 steam tugs of 6,272 tons.

In addition there were 1,952 sailing vessels of 95,175 tons and 243 lighters and barges of 62,066 tons. The vessels were loaded as follows:—95 with passengers, 255 with coal, 135 with stone, 59 with iron, 679 with timber, 682 with grain, 22 with cattle, 607 with ore and other bulk goods, 907 with piece goods, 72 with general cargoes and 1,204 empty or in ballast.

Although there is a decline in most cargoes, corresponding to the fall in the return, there were increases in the coal, iron and grain cargoes.

Personal enquiries regarding shipping and transport matters should be made at the City Office of the Department (Shipping and Transport Section), 73, Basinghall Street, London, E.C.2.

DEE CONSERVANCY AWARD.

A reserved judgment by Sir W. F. K. Taylor, K.C., the presiding Judge of the Liverpool Court of Passage, was delivered in the action at the October Court in which the Dee Conservancy Board and Messrs. John Summers and Sons, Ltd., sued John McConnell and Samuel Chambers, of Kilkeel, Ireland, the owners of the ketch William Shepherd, for damages for negligence through the sinking of the ketch in the Dee, and thereby becoming an obstruction to Messrs. Summers' wharf and the navigation of the river.

On July 12th, 1926, the William Shepherd was loaded with basic slag by Messrs. Summers' men, the master and mate of the ketch watching the loading. The Judge said he was satisfied that the loading was properly trimmed, spread and done, and had nothing to do with the sinking of the vessel. After loading, the two members of the crew left, being dissatisfied with the remuneration they were getting, and she was subsequently unattended, with no one to look after her.

There were several seams open above the 10 ft. mark, and when the ketch had been moved, owing to the absence of pumping, she took in water and gradually sank. The Judge added that he was convinced that the master and mate, as well as the owners, knew that the ketch needed repair. The Dee Conservancy Board instructed the Salvage Association to raise the vessel and so remove the obstruction, and this was the most reasonable and cheapest way of dealing with her. In doing this the Dee Conservancy incurred a cost of £1,569, and the Judge found that they were entitled to that sum.

With regard to Messrs. Summers' claim, the Judge found that no physical damage was done to their wharf, and they had proved no loss at the trial, and on this claim defendants were entitled to judgment, but without costs.

In giving judgment, as stated, the Judge said: "Any reasonable man would anticipate that which happened. I am of opinion that the vessel was unseaworthy, and that the owners' negligence was the cause of the accident and subsequent damage."

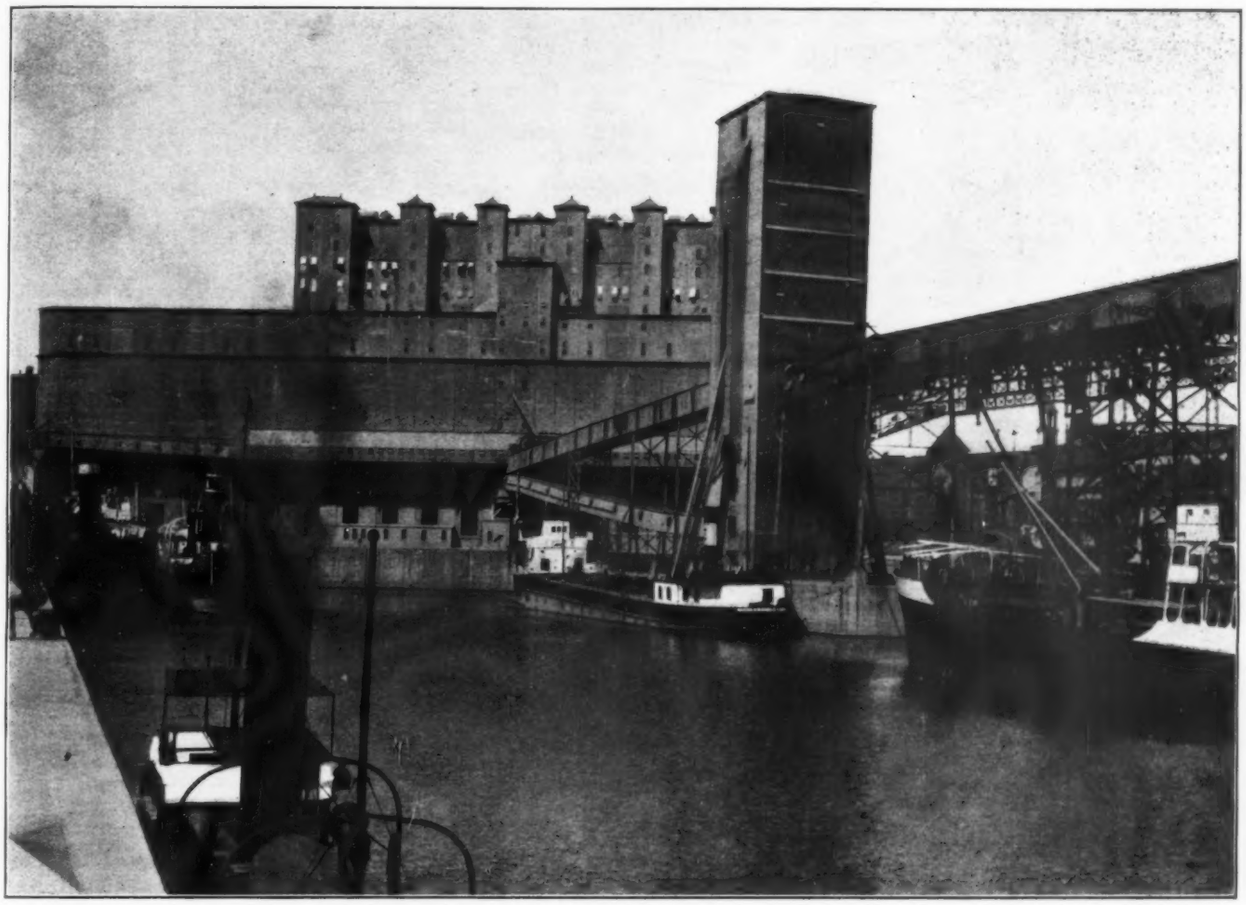
GDYNIA QUAY DAMAGED.

One of the quays for loading coal at Gdynia, Poland, was damaged at the end of October, causing a considerable delay to shipping owing to the fact that all other quay berths, except one, are controlled by the Robur concern.

The Port of Montreal.

The History and Facilities of a Great Inland Harbour.

By LAURENCE CHALMERS TOMBS, M.A.



Elevator No. 2, with Marine Tower Jetty, Montreal.

INTRODUCTION.

FROM time immemorial the River St. Lawrence has been the natural gateway of North America. Nearly four hundred years ago, Jacques Cartier sailed up the St. Lawrence until he reached Hochelaga, one thousand miles from the sea. A century passed, and the then deserted Hochelaga, lying at the foot of the Royal Mountain, became Maisonneuve's Montreal. Montreal owed its conception and birth to religious zeal. However perilous an outpost to the attacks of the Indians, it was admirably situated as a mission at the junction of two great rivers, the St. Lawrence and the Ottawa, the key to a vast network of inland waterways. " Villemarie de Montréal " was founded by Paul de Chomedey, Sieur de Maisonneuve, on May 17th, 1642. Thirty-one years before, Champlain had chosen the site as one fit for settlement.

The foundation of Montreal has been described thus: " Maisonneuve sprang ashore and fell on his knees. His followers imitated his example; and all joined their voices in enthusiastic songs of thanksgiving. Tents, baggage, arms and stores were landed. An altar was raised on a pleasant spot near at hand. . . They kneeled in reverent silence as the Host was raised aloft; and when the rite was over, the priest turned and addressed them: ' You are a grain of mustard seed that shall rise and grow till its branches overshadow the earth. You are few, but your work is the work of God. His smile is on you and your children shall fill the land ' . . . The afternoon waned; the sun sank behind the western forest, and twilight came on. Fireflies were twinkling over the darkened meadow. . . . Then they pitched their tents, lighted their bivouac fires, stationed their guards, and lay down to rest. Such was the birth-night of Montreal." (a)

To Montreal came Indians bartering furs for the novel wares of the French. From Montreal missionaries of the Cross, explorers and " coureurs de bois " blazed their difficult paths up the St. Lawrence and the Ottawa to the Great Lakes and beyond, and down the Ohio and Mississippi to New Orleans, a sister French settlement, and the Gulf of Mexico. After one hundred and twenty years the " ancient régime " gave way to the British. The bilingual character of Montreal had begun.

(a) Parkman, The Jesuits in North America, 1867, pp. 302-303.

Vigorous Scotsmen inspired the fur trade to new and widespread enterprises in the North-West Banks, warehouses, ships and railways were the creation of these industrious men of penetrating foresight. The names of Allan, Angus, McGill, McTavish, Molson, Mount Stephen, Redpath, Simpson and Strathcona stand out among the greatest citizens of Montreal and Canada. The scattered units of the Canadian nation gathered together by Confederation in 1867, were linked in an economic sense by the completion of the Canadian Pacific Railway in 1885, built by Montreal capital and enterprise. There has been a steady flow of immigration, at times reaching immense proportions, (b) to and through Montreal since 1890. Up to the beginning of the present century this was chiefly of British origin.

POPULATION.

Montreal has grown to be the largest and richest city of Canada with a population of one million inhabitants. (c) It is the first grain port of the world and the second most important harbour in North America. It is the headquarters of the two greatest banks of the Dominion, the two railway systems, and the ocean and inland steamship lines. It manufactures iron and steel, machinery, cottons and woollens, cement, sugar, flour, ale and beer, tobacco, boots and shoes, clothing, oils, paints and many other commodities. The executive or sales offices of the principal dairying, pulp, paper, timber, coal and hydro-electric interests are situated in Montreal.

(b) In 1913, 40,432 immigrants entered Canada, the greatest number in any one year.

(c) Population of the City of Montreal in ten year periods from 1851 to 1911 (Federal Census) and estimates for the last five years:

1851	57,715	1911	522,377
1861	90,323	1921	*801,216
1871	107,225	1922	*863,188
1881	140,747	1923	*941,529
1891	211,032	1924	*979,027
1901	277,829	1925	*1,028,000

Authority 83rd Annual Report, Montreal Board of Trade, 1925.

* Compiled by Lovell's Directory, Montreal.

NATURAL POSITION.

Montreal is the farthest inland harbour of importance in the world, standing at the head of deep-water navigation on the St. Lawrence, 1,000 miles from the sea at the junction of ocean and inland navigation. It is approached by a ship channel of 30 ft. at low water, which is being increased to 35 ft. and is connected with a great canal and lake system of 1,600 miles of inland navigation extending into the heart of the North American continent.

Distance from the Sea of Certain Ports.

Port.	River.	Distance from Sea in Statute Miles.
Iquitos	Amazon	2,200
Montreal	St. Lawrence	1,003
Manaos	Amazon	900
Hankow	Yangtse	615
Baltimore	Patapsco	180
New Orleans	Mississippi	114
Portland, Ore.	Willamette	113
Calcutta	Hugli	86
Hamburg	Elbe	67
London	Thames	67
Philadelphia	Delaware	63
Bordeaux	Gironde	60
Bremen	Weser	54
Manchester	Mersey	54
Antwerp	Scheldt	50
Newcastle	Tyne	20
Rotterdam	Nieuwe Maas	18
Glasgow	Clyde	18

The growth of the port of Montreal has been rapid and continuous. It is the ocean port nearest to Central Canada and the Prairie Provinces, also to the Middle States.

Comparative Rail Milages to Eastern Ports.

From	To Montreal, Quebec.	New York, N.Y.	Boston, Mass.	Baltimore, Md.	Philadelphia, Pa.
Buffalo N.Y. ...	436	396	481	396	408
Chicago, Ill. ...	841	899	979	796	817
Cleveland, Ohio ...	579	579	664	461	480
Detroit, Mich. ...	557	649	734	632	651
Duluth, Minn. ...	1043	1273	1365	1273	1285
Fort William, Ont.	998	1271	1320	1349	1356
Kansas City, Mo....	1293	1373	1458	1206	1301
Minneapolis, Minn.	1129	1211	1303	1211	1223
St. Louis, Mo. ...	1046	501	585	501	512
Winnipeg, Man. ...	1417	1690	1740	1767	1782

Montreal is closer to Europe than any other large North American port.

Comparative distances from the principal Atlantic Ports to Liverpool (Philips' Distance Tables).

	Nautical Miles.		Nautical Miles.d
Halifax	2,492	New York	3,043
Quebec	2,625	Philadelphia	3,179
St. John	2,674	Baltimore	3,335
Montreal	2,760	New Orleans	4,532
Portland	2,783	Galveston	4,726
Boston	2,861		

It is favourably situated as compared with other great ports.

Comparative distances in nautical miles showing relation of Montreal to other large ports. Authority: Philips' Distance and Speed Tables for Shippers.

To	From Montreal.	New York.	New Orleans.	London.	Sydney.	Buenos Aires.
Antwerp	3281	3310	4822	180	11578	6334
Auckland	9776	8605	8013	11375	1264	6249
Barbados	2715	1825	2115	3801	8957	4169
Buenos Aires	6421	5838	6255	6294	9564	
Calcutta	9783	9795	11138	7902	5748	9225
Cape Town	7108	6792	7347	6117	6279	3778
Copenhagen	3239	3554	5228	587	12005	6761
Demerara	3095	2194	2401	4078	9196	3859
Gibraltar	3194	3206	4549	1313	10231	5282
Hamburg	3548	3577	5068	427	11845	6601
Havana	2475	1197	585	4259	8179	5669
Liverpool	2760	3043	4532	638	11501	6258
London	3241	3270	4761		11538	6294
Panama	3183	2012	1420	4782	7692	5280
Singapore	10129	10141	11484	8248	4306	9375
Sydney	10875	9704	9112	11538		9564
Vancouver	7260	6089	5497	8859	6848	8336
Yokohama	10885	9714	9122	11150	4316	12105

ADVANTAGEOUS POSITION.

It is situated in the centre of the fertile St. Lawrence valley and the vast hinterland of Quebec and Ontario.

The geographical location of the Port of Montreal gives it a double advantage over United States Atlantic ports, for it is not only one or two days' steaming nearer Great Britain, but it is also closer to producing and consuming points in Central and Western Canada and the Middle States. The importer and exporter benefit by reduced inland freight charges and considerable saving of time in transit. The St. Lawrence canal route to Montreal is 110 miles shorter than the American water route to New York, and has a cargo capacity of 90,000 bushels per vessel unit, while that of the Erie Canal has but 53,000 bushels per unit. Montreal can show still more striking advantages than New York in the water and rail route. The shortest water and rail route from Fort William to Montreal is 923 miles, 336 miles less than the shortest route to New York and Baltimore.

(d) This is the Admiralty knot of 6,080-ft., approximately one and one-fifth statute miles.

The area drained by the River St. Lawrence from the head of Lake Superior to Gaspé, a distance of 2,100 miles, is 510,000 square miles, of which 322,000 square miles lie in Canadian territory. The drained area amounts to 480,000 square miles at Montreal, or more than four times the area of Great Britain and Ireland. The yield of water from such a vast area would, in most of the great rivers of the world, cause tremendous fluctuations in flow. Instances of sudden and extreme changes developing floods are of common occurence, e.g., the Mississippi, the Columbia and other large streams. This is totally absent in the St. Lawrence, the Great Lakes acting as storage reservoirs, the effect of which is to render the flow more regular throughout the year than any great river in the world. The immense average flow of 8,500 tons of water passing Montreal every second is at times exceeded. (e)

THE SHIP CHANNEL.

The ship channel of the St. Lawrence extends a distance of 210.4 statute miles from Montreal to South Traverse, 50 miles below the Port of Quebec. Beyond South Traverse the St. Lawrence has sufficient depth and width for any vessel. The general minimum depth of water in the ship channel between Montreal and Quebec, varies from about 35 ft. at high water in the tidal portions of the river, and in time of freshets in early summer, in non-tidal portions; to 30 ft. at ordinary low water in the autumn, or even to 29 ft. in occasional years of excessively low water. The low stage of the river, ordinarily reached about September 15th, continues till after the close of navigation at the end of November. Quebec and Montreal are separated by a distance of 160 miles, of which a series of deep water sections totalling some 88 miles in length required no improvements except marking by lights and buoys. Throughout a total distance of 71 miles, however, many obstructions to navigation existed and very expensive dredging was necessary in the construction of the present 30 ft. channel. The original channel had a depth of only 11 ft. through the shoals and flats of Lake St. Peter. The channel has a minimum width of 450 ft. throughout the straight portions, and from 550 to 750 ft. at the bends. It is well marked throughout by buoys, light buoys and range lights. Most of the buoys are removed at the close of the season of navigation and replaced in the spring. Sea-going vessels pass up and down the river as freely by night as by day.

The opening and closing of navigation, and the first arrival and last departure of sea-going vessels in the Harbour of Montreal since 1874; also when the channel between Quebec and Montreal was clear of ice.

Year.	Channel Clear Quebec to Montreal.	Opening of Navigation.	Closing of Navigation.	First Arrival from Sea.	Last Departure for Sea.
1874 ...	May 10	April 25	Dec. 13	May 11	Nov. 21
1875 ...	May 8	May 3	Nov. 29	May 9	Nov. 22
1876 ...	... ...	April 27	Dec. 10	May 8	Nov. 23
1877 ...	April 25	April 17	Jan.'78 2	April 29	Nov. 24
1878 ...	April 13	Mar. 30	Dec. 23	April 20	Nov. 24
1879 ...	May 1	April 24	Dec. 19	May 1	Nov. 24
1880 ...	April 30	April 17	Dec. 3	May 2	Nov. 22
1881 ...	April 24	April 21	Jan.'82 2	April 26	Nov. 23
1882 ...	April 23	April 11	Dec. 9	May 6	Nov. 21
1883 ...	May 4	April 27	Dec. 16	May 5	Nov. 20
1884 ...	April 28	April 22	Dec. 18	May 2	Nov. 20
1885 ...	May 7	May 5	Dec. 7	May 8	Nov. 20
1886 ...	April 26	April 24	Dec. 4	April 30	Nov. 25
1887 ...	May 1	May 1	Dec. 23	May 3	Nov. 28
1888 ...	May 1	April 29	Dec. 14	May 4	Nov. 22
1889 ...	April 22	April 14	Dec. 29	April 27	Nov. 23
1890 ...	April 27	April 14	Dec. 3	April 30	Nov. 24
1891 ...	April 25	April 17	Dec. 17	April 27	Nov. 21
1892 ...	April 21	April 13	Dec. 23	April 23	Nov. 27
1893 ...	May 1	April 24	Dec. 4	May 3	Nov. 23
1894 ...	April 23	April 12	Dec. 26	April 27	Nov. 24
1895 ...	April 27	April 20	Dec. 5	April 27	Nov. 25
1896 ...	April 24	April 22	Dec. 19	April 26	Nov. 23
1897 ...	April 26	April 17	Dec. 19	April 30	Nov. 24
1898 ...	April 10	Mar. 31	Dec. 12	April 26	Nov. 28
1899 ...	April 26	April 24	Dec. 30	April 27	Nov. 29
1900 ...	April 26	April 21	Dec. 10	April 26	Dec. 3
1901 ...	April 19	April 21	Dec. 10	April 25	Nov. 25
1902 ...	April 13	April 5	Dec. 8	April 17	Dec. 4
1903 ...	April 11	April 2	Dec. 10	April 26	Nov. 28
1904 ...	April 27	April 25	Dec. 9	May 4	Nov. 27
1905 ...	April 20	April 19	Dec. 12	May 2	Nov. 30
1906 ...	April 18	April 20	Dec. 2	April 28	Dec. 2
1907 ...	May 1	April 23	Dec. 15	May 2	Nov. 29
1908 ...	April 28	April 22	Dec. 10	April 30	Nov. 26
1909 ...	April 18	April 16	Dec. 27	April 23	Nov. 28
1910 ...	April 3	April 1	Dec. 7	April 11	Dec. 1
1911 ...	April 25	April 23	Jan.'12 1	April 26	Dec. 3
1912 ...	April 29	April 23	Jan.'13 3	April 30	Dec. 3
1913 ...	April 14	April 3	Dec. 27	April 19	Nov. 29
1914 ...	April 25	April 22	Dec. 23	April 29	Dec. 4
1915 ...	April 14	April 11	Dec. 15	April 30	Dec. 11
1916 ...	April 22	April 22	Dec. 18	May 1	Dec. 3
1917 ...	April 22	April 19	Dec. 7	May 1	Dec. 7
1918 ...	April 22	April 21	Dec. 17	May 7	Dec. 14
1919 ...	April 16	April 14	Dec. 12	April 22	Dec. 10
1920 ...	April 18	April 18	Dec. 11	April 25	Dec. 7
1921 ...	Mar. 29	Mar. 29	Dec. 14	April 21	Dec. 8
1922 ...	April 13	April 13	Dec. 6	April 24	Dec. 2
1923 ...	April 29	April 29	Dec. 18	May 3	Dec. 2
1924 ...	April 17	April 18	Dec. 13	April 24	Dec. 3
1925 ...	April 10	April 16	Dec. 10	April 16	Dec. 3

(e) Adapted from Henry Holgate, Consulting Engineer, Montreal. Discussion on the St. Lawrence River and Great Lakes.

There are no difficulties of navigation from physical disturbances. The waters of the St. Lawrence, which are probably clearer and purer than those of any other inland waterway in the world, are unusually free from fog and storms. Slight fog is occasionally experienced in the Gulf in July and August, but it is, as a rule, of short duration.

The rate of the current varies very considerably from place to place. It is greatest at St. Mary's Current, opposite the eastern section of Montreal, at Cap à la Roche, 108.4 miles below Montreal, and at Richelieu Rapids, 12.6 miles beyond. In St. Mary's Current the flow is from 6 to 7 miles per hour. Up-stream vessels regulate their time of departure from Quebec in order to arrive at the foot of the Richelieu Rapids with the flood tide. The shallowest part of the river between Montreal and Quebec is at St. Augustin shoal 15 miles above Quebec; part of the channel here has a depth of only 22 ft. at extreme low water. The spring tide rises 18½ ft. and the neap tide 13 ft.; ships of heavy draught await the flood tide and are guided by the semaphore tidal signals. The rate of the ebb stream is 3½ knots and that of the flood about 3 knots. A similar condition exists at Cap à la Roche. The Traverse, 50 miles below Quebec, is the critical point of the Lower St. Lawrence, the tidal streams here attaining their greatest strength. In South Traverse the rate of the ebb is 7 to 8 knots and that of the flood 6 to 7½; spring tides rise 18½ ft. and neap tides 13 ft. The channel, also, is relatively narrow. From the Traverse to the open sea no obstacles of either low water or tidal currents affect navigation. (f). There is no tide at Montreal, it being dissipated in Lake St. Peter, midway between Quebec and Montreal.

WINTER CONDITIONS.

The great problem of the port of Montreal is the closing of the River St. Lawrence to navigation during the five winter months of the year. Despite, however, the absolute cessation of transportation on the St. Lawrence during this period, the Harbour of Montreal is now engaged in business the entire year. Formerly, the close of the open season of navigation meant the virtual stoppage of business on the river front. The old wooden freight sheds were dismantled, removed for fear of high water and re-erected in the following spring.

The Canadian Pacific Railway has for twenty winters used sheds Nos. 7 and 9, King Edward Pier, for the delivery of import freight brought up from West St. John. The cars are placed at the sheds by the harbour railway and the goods unloaded by the Canadian Pacific; and upon clearance from customs and payment of the freight charges, are delivered to the importers. (g) Shed No. 2 is used as a storage warehouse for flour arriving by rail which is later delivered to city bakeries, or re-shipped in cars to various points in Quebec and the Maritime Provinces, at the balance of the through freight rate plus the usual stop-off charges and harbour switching. Shed No. 16 was utilised in the winter of 1925-26 for the storage of automobiles for local distribution. The harbour elevators are also in operation. About 6½ million bushels of grain were in storage during the winter of 1925-26. The cold storage plant is fully operated throughout the year. The harbour traffic department, which controls the switching operations on the water front, moves cars continuously to and from the various railway companies for the manufacturing plants located on, or adjacent to, the harbour tracks which extend from section No. 12 at the foot of McGill Street to oil tanks at section No. 101, a distance of 9 miles. Ocean space is contracted for, bills of lading are issued and business is conducted at Montreal on similar lines to the open season. A small percentage of the steamship staffs, however, move temporarily to the winter ports of St. John and Halifax, and, or Portland. Early in April, goods begin to reach Montreal for the first vessels.

THE ICE PROBLEM.

The St. Lawrence, which makes the ice problem peculiarly difficult, flows northward through the snow belt subject to severe winter conditions. Snow occasionally falls in November. About the 1st of December, ice formation begins along the shores and upon the shoals. As winter approaches, this " bordage " ice spreads and encroaches upon the main channel. The increasing cold chills the water of the main channel, almost the whole surface of the river being covered with moving " frazil " ice. These two kinds of ice increase until the St. Lawrence is closed for navigation in December. The level of water in the river is at its lowest stage from about September 15th to the end of November.

Under normal conditions an ice jam forms at the foot of Lake St. Peter early in December. As soon as the bridge or jam forms, it stops the floating ice and the pack sets in at once running back and covering the whole river to Montreal. Towards the end of December, or the beginning of January, ice jams may form at Portneuf or at Cap Rouge. On several occasions the river has remained open during the entire winter from the foot of Lake St. Peter to the Gulf. A block at either Portneuf or Cap Rouge (Quebec Bridge) is a very heavy and serious obstruction, the jammed ice reaching a thickness of from 60 to 80 ft., and growing rapidly up-stream until the river is covered to the foot of Lake St. Peter, where the ice first stopped running in the late autumn. This heavy ice is only found in the vicinity of the jam, gradually decreasing up-stream, and at a distance of some two miles above is reduced to ordinary surface ice of from 2 to 3 ft., intersected here and there by ridges of packed ice and frazil.

These jams at Portneuf and Quebec Bridge are formed in two ways, either by large fields of " batture " or shore ice lifting off at high tide, floating down and jamming, or by the river freezing across at slack tide when the weather is very cold and calm. These heavy jams caused very severe flooding and great damage in the upper reaches of the river from Grondines to Sorel. Ice-breakers were introduced to keep the river open as far above Quebec as possible. This work, undertaken for the first time in 1908, has been carried on with great success, serious floods having been practically eliminated. While the first aim of the ice-breakers has been to prevent floods, it is important to notice that as a result of these operations, the season of navigation has been lengthened, as an average figure, twelve days, the opening being five days earlier in the spring and the closing seven days later in the autumn.

In the late autumn, ice-breakers are stationed at Trois-Rivières to keep the foot of Lake St. Peter open until the last vessels have passed out. They are then withdrawn to Quebec, where they stay in readiness to rush to any point where danger threatens as far up the river as Portneuf. Assuming that the river has been kept open to about Batiscan, approximately 58 miles above Quebec, the next step is the breaking of the ice above this point. The work is undertaken by the ice-breakers about the 1st of March, being pushed ahead until the river has been cleared to above the foot of Lake St. Peter. In carrying out the above operation, the ice-breakers cut a channel of from 1 to 2 miles in length by 300 to 400 ft. in width, depending on existing conditions. They then drop back and widen or slice the ice on either side of this channel, working in to the limit of their draught, in order to make sure that any ice that breaks away will have a free passage. When the widening has been satisfactorily carried out, the cut is pushed forward another mile or two and widened. These operations are repeated until the objective near the foot of Lake St. Peter is reached.

By the time the river has been cleared of ice to a point somewhere above the foot of Lake St. Peter, the ice farther up in the Lake and in the river above is usually ready to move. The large area of ice in Lake St. Peter must pass out through the comparatively narrow opening at the foot of the Lake. This ice invariably jams there. After the ice-breakers have cleared the river of ice to some point in Lake St. Peter, they remain below the foot of the Lake and break up any jams that may form, keeping the ice steadily moving down without interruption as far as possible. Very shortly after Lake St. Peter is open, the river above is clear to Montreal.

During the seven or eight months of the year when ice-breakers are not required, the C.G.S. *Mikula*, *Montcalm*, and *Lady Grey* are docked, overhauled and variously employed in Government patrol service. From 1908 to 1921, the *Montçalm* and *Lady Grey* were employed, and from 1922 to date, the *Mikula* and the *Lady Grey*, the *Montcalm* having been detailed to the Atlantic Coast.

INSTANCE OF FLOODING.

Since 1908 there has been no flooding, with the exception of the year 1912, when the ice-breaking service broke down, owing to the fact that the *Lady Grey* was cut off from Quebec and had to winter at Three Rivers, the *Montcalm* alone being unable to contend with the ice at Cap Rouge. The river was covered with ice from Cap Rouge to Montreal, and there was very severe flooding in the spring, the water reaching a height of 18 ft. 4 in. above extreme low water at Three Rivers, and the country being inundated for miles, with the channel clear of ice to Montreal only on April 29th. (h)

The floods near Montreal are entirely local and are due to an excessive quantity of ice. Although due to ice-formation, they differ from the ice gorges in the southward flowing rivers in the United States. There is an elevation of the river level at Montreal which continues throughout the winter during the closed season of the St. Lawrence. The river reaches its highest winter level from the packing of the ice in December or January, and its highest spring level in April from the break-up and departure of the ice. The intensity of the floods and ice jams at Montreal is due to the physical features of the St. Lawrence River. The St. Lawrence between Prescott, 120 miles up-stream from Montreal, and the lower end of Lake St. Peter, 80 miles below Montreal, consists of a series of broad, lake-like expansions connected by relatively narrow and, in places, rapid reaches. The principal lakes are Lake St. Francis, Lake St. Louis, the Laprairie Basin and Lake St.

(f) Authority: Tide Tables, etc., Department of Marine and Fisheries, Ottawa, 1925.

(g) In Montreal, the railway cartage agents generally collect and deliver all package freight, unless the owner of the goods prefers to do same.

(h) Forneret, V. W., Superintending Engineer. Ice-breaking Operations in River St. Lawrence between Montreal and Quebec. Memorandum to the Deputy Minister, Department of Marine and Fisheries, Ottawa, Canada, March 18, 1926.

Peter. This section of the river, which is approximately 200 miles in length, is characterised by a relatively slow sluggish current through the lakes and by extremely swift water over the rapids.

The term " frazil " ice is applied to flake-like particles of ice of a dull leaden hue intimately mixed with, and carried in suspension by, the water. It forms on the approach of zero weather in all rapid parts of the St. Lawrence River between the border ice from Prescott to Lake St. Peter, until Lake St. Louis and the river above are closed. Then it forms in the open area, which remains open all winter, from the foot of the Lachine Rapids to Lake St. Louis. Bordage ice resists submergence with great force, while frazil ice, being saturated with water, is carried easily by the current into submerged channels until grounded in shallow water or arrested against the under side of the field ice to which it freezes. This frazil, although porous and saturated with water, is an exceedingly effective obstruction to the flow of the river. (i)

The floods and ice shoves, which accompany the break-up and departure of the ice at Montreal, do not differ from those in other rivers. The islands and flats constitute obstructions to the ice in motion and divert enormous masses into the narrow main channel. This ice partly blocks the channel, causing the water in the harbour to rise much in excess of that in the wider parts of the river. The floods and ice shoves, which are due to the physical characteristics of the St. Lawrence River at and near Montreal, have necessitated striking adjustments in the development of the port. The slack water basin has been protected from ice shoves and swift currents by the Guard Pier. The revetment wall keeps the flood waters out of the lower part of the city. High level piers have been constructed to make possible permanent sheds and elevators.

The St. Lawrence below Quebec seldom, if ever, freezes over. The s.s. *Canadian Voyageur* left Quebec on January 21st, 1919, and arrived at Halifax, February 4th, having been convoyed by the C. G. S. *Montcalm* from the Gulf. Government vessels are moving in the river around Quebec all winter. Sealers and the Newfoundland passenger boats navigate Cabot Strait between Cape Breton and Newfoundland throughout the year.

DRIFT ICE.

The Gulf of St. Lawrence has an area of 101,562 square miles. Cabot Strait, its principal entrance, is 55 miles wide; Belle Isle Strait is about 10 miles wide. It is also connected with the ocean by the Gut of Canso, half-a-mile wide, separating Cape Breton from the Novo Scotian mainland. The rate of current in the Gulf seldom exceeds one mile per hour. From early spring until May, parts of the Gulf are covered with drift ice. Ice from the Gulf is generally met with in Cabot Strait early in January. At this time it is thin, but it increases gradually to as much as 4 ft. in thickness. Small bergs are seen occasionally but a large berg is seldom visible. Ice may flow through until May or the beginning of June. Nearly every year between the middle of April and the middle of May, the ice packs between St. Paul Island and Cape Ray. In the Strait of Belle Isle, thin sheet ice makes its appearance between December 15-25; early in January, ice 3 to 10 ft. in thickness passes between Labrador and Belle Isle, and drifts into the Strait. Icebergs, liberated from northern regions in the previous summer, do not begin to arrive in any great number until April. The greater number of the bergs enter between Belle Isle and Labrador and pass slowly through this Strait frequently grounding and breaking up. No bergs drawing more than 30 fathoms of water can reach the westerly end of the Strait with easterly winds during the latter part of May. The first steamers enter the Strait between June 7th and July 25th, and the last pass out from November 11-25.

The following press dispatch dated from Halifax, April 17th, 1926, is indicative of the ice conditions which exist at times in the Gulf:—" The Canadian Government ice-breaker *Mikula*, operating in Cabot Straits, reports a navigable track from Cape Ray to Quebec. The following intercepted message from the *Mikula* reached C. H. Harvey, local agent of the Marine and Fisheries Department, this morning: ' Track from 15 miles, North Cape, via Biard Rock to Quebec, is practically clear of ice. Magdalen Islands in heavy slob, packed and open ice. Gut of Canso and Northumberland Straits hardly navigable. Sydney Harbour not yet clear, Louisburg clear of ice *Mikula* patrolled this morning from 48.12 north, 59.45 west, to 47.33 north, 59.58 west, on northern edge of ice track previously reported. Heavy swell heaving through and ice very much broken in weather edge.' The department was further advised that the ice breaker *Montcalm* is in the vicinity of the Magdalen Islands, awaiting the opportunity to land mails and supplies."

HISTORY OF THE PORT.

Navigation of the St. Lawrence in the years of the French régime was difficult owing to the scarcity of charts, lights and buoys to mark the channel. (j) Trade was nevertheless carried on with the Indians and an irregular service existed between Montreal, Three Rivers and Quebec during the seven open months of the year. The birch-bark canoe was the earliest craft on the St. Lawrence and the Great Lakes. For many years furs were the only traffic to which much importance was attached. The cargoes of a few rich canoes required comparatively little labour to transport them down to Montreal and into the hold of a merchantman. The fur market was managed by a few agents of European houses. Following the canoe came the bateau (k) which had been first built as early as 1679 by La Salle who launched his *Griffon* above Niagara Falls, only to lose her soon afterwards on Lake Michigan. Prior to 1790, little else than the bateau was used. While furs were the only exports, this type of boat was suited to the trade in both directions. A little grain was first sent down from Upper Canada about the year 1800 on rafts, and also in scows, or " arks," which were broken up and sold as lumber in Montreal. Up-stream merchandise was carted to Lachine whence the bateau and *Durham* boats (l) sailed through Lake St. Louis bound for the Upper St. Lawrence and the Great Lakes in batches of five or more, in order that their united crews might help one another at the rapids. From Champlain's time venturesome spirits navigated the Ottawa, then made the portage across to Lake Huron, a route somewhat similar to the Georgian Bay Canal projected three centuries later, on their way to the North-West.

The establishment of " La Maison de la Trinité de Québec " (m) in 1805, foreshadowed that of the Trinity House of Montreal in 1839. (n) The Quebec Trinity House had absolute control of pilotage and navigation generally. (o) In the year 1805, vessels took from two to three weeks to come up the river from Quebec to Montreal and even then they only proceeded as far as Hochelaga at the foot of St. Mary's Current, about 2 miles below the Montreal Post Office. In order to reach the harbour, it was necessary to employ from 10 to 12 oxen, at times even 16, unless the winds were favourable, to tow ships up the current. Pilots only made from two to three trips per year. The usual marks of the channel in the river were not buoys or lights, but churches, houses, trees and other landmarks.

In 1824, two stone windmills marked the progress of industrial development to the west of what is now McGill Street, being situated at the top of the open beach. " Sloping roadways down to the water where the river was so low as to permit of rocks showing above the current, a long stretch of beach where the children of those days romped and played, and the poorer women washed their linen, using the big stones as washing boards, a long, unbroken line of trees and shrubberies past Maisonneuve, where now the Harbour Commissioners' powerful locomotives transport merchandise from vessels of 16,000 tons register to the various railway terminals—these were the features of the Port of Montreal long before Confederation had even been dreamed of." (p.)

AN EARLY WHARF.

One small wharf, 200 ft. in length, in the position of the flood wall of to-day, opposite the present Harbour Commission's office on Common Street, provided accommodation for vessels of 9 ft. draught. Another irregular wharf, known as Berthelette's, was situated between the Harbour Commission's office and the Old Customs House at the corner of Youville Square. The draught of Lake St. Peter was limited to 11 ft., even that depth was not available in the Harbour of Montreal, and the shipping trade of the whole season could have been carried in one of the modern ships which now frequents the port. From the Little River, which flowed into the St. Lawrence near the Old Customs House, downward, the beach was unimproved save for a number of roads down to the water.

(i) Adapted from Barnes, Howard T., Ice Formation, Montreal, 1915, and Keefer, T. C., Floods at Montreal, 1890.

(j) The first real chart of the St. Lawrence River was drawn in 1759 by the great explorer, Captain James Cook, who charted the river between Quebec and the sea for Wolfe's expedition.

(k) The bateau was a large, flat-bottomed skiff, sharp at both ends, about 40-ft. long and 6 to 8-ft. wide in the centre, and capable of carrying about 5 tons of cargo. It was provided with masts and lug sails, with about 15-ft. hoist, an anchor, 4 oars and 6 setting-poles shod with iron. The bateau, a very safe and adaptable vessel, was managed by a crew of 4 men and a pilot.

(l) The " Durham " boat, introduced by the Americans about 1812, was a flat-bottomed barge with keel and centre-board, rounded bows, 80-90-ft. long and 9-10-ft. beam, and with a cargo capacity of ten times that of a bateau down-stream, but owing to rapids and lack of return freight, it averaged westbound only about 8 tons.

(m) The original Trinity House was incorporated in 1518 by Henry VIII. for the care of lighthouses and navigation. Part of its gorgeous official title remains to this day: " The Fraternity of Brotherhood of the Most Glorious and Undivided Trinity."

(n) Trinity House was absorbed by the Harbour Commission of Montreal in 1873.

(o) The first pilotage Act on record was passed by the Legislature in 1788 regulating the pilotage of the River St. Lawrence and the Port of Quebec. Pilotage at that date was $2.75 per foot to Quebec. In 1925 the pilotage rate from Father Point to Quebec (May 1 to November 10, after which rates increase very considerably) was $3.87 per foot of draught water.

(p) Atherton, W. H., History of Montreal, 1915, Volume II., p. 588.

Agitation for a St. Lawrence ship channel was initiated in February, 1926, when a petition was read before the Legislative Assembly of Lower Canada, urging the necessity of improving the means of communication between the Canadas and Europe. The petitioners stated that, according to their survey, the obstructions in the St. Lawrence at Ile la Platte and in Lake St. Peter could be successfully removed for a length of 7 miles, a breadth of 75 ft., and to a depth of 16 ft. at low water, at the cost of £36,000 currency, which included the maintenance of a channel for three years. The merchants of Montreal were unanimous in pointing out to the Government the enormous losses to the trade of Lower Canada resulting from lighterage over the shoals of Lake St. Peter. No action was taken by the Legislature, and in 1836, the merchants of Montreal again presented a petition praying for a grant of money to carry out an accurate survey of Lake St. Peter and the river as far as the Port of Montreal. The paltry sum of £520 was granted two years later.

HARBOUR COMMISSIONERS.

On May 8th, 1830, the Hon. George Moffatt, (q) Jules Quesnel and Capt. R. S. Piper, R.E., were appointed commissioners, under the Great Seal of the Province of Lower Canada, to carry into effect an Act of the Provincial Legislature, 10 and 11 Geo. IV., chap. 28, " An Act to provide for the improvement and enlargement of the Harbour of Montreal." The first works undertaken were for the construction of wharves, ramps, slips for " Durham " boats, a revetment wall and a bridge to Oyster Island, which was to be the principal wharf. The appropriations for the first three years amounted to £81,000, or approximately $400,000. At the end of this period there was no provision for future improvements, the revenue was suspended and the dues were evaded, with the result that the whole staff was discharged, except the Secretary whose services were retained at a reduced salary of $250. This was the first attempt to improve the Harbour of Montreal by a Commission. The first plan of improvement, prepared by Capt. R. S. Piper, in 1829, was enlarged by Peter Fleming, C.E., in 1830, and carried out by the first commissioners.

Nothing further was done to improve the St. Lawrence channel until the presentation of another petition to the Assembly in 1841. Two years later, the Legislature voted a sum of money for the deepening of the Channel to 14 ft. at low water and directed the Board of Public Works to commence operations for that purpose. Until 1844, the Government were undecided whether to use the old, natural, or " crooked " channel, or make a new, straight cut. A decision was finally given in favour of the straight cut and this work was begun in the spring of the same year. It was never completed, however, its final suspension taking place in September, 1847. Some $320,000 had been expended without practical results.

The propeller was now taking the place of the sailing vessel and the St. Lawrence was open to American trade. (r) The day was not far distant when Montreal would become the outlet for some of the trade which was rapidly overcrowding the capacity of the enlarged Erie Canal and the American railways running from the states bordering the Great Lakes to the Atlantic. The lake propeller would connect with the ocean screw steamer at the head of ship navigation on the St. Lawrence, wherever that might be. That point had to be either Quebec or Montreal. At the time it appeared to be a matter of indifference to the province at large which became the favoured port and that, therefore, the deepening of the St. Lawrence between these two cities was a local or " Montreal " question. This consideration appears to have influenced the Legislature to abandon the Province's attempt to deepen Lake St. Peter in 1847.

SHIPPING CONSIDERATIONS.

The extension of a deep water port on the St. Lawrence, 160 miles above the traditional port of Quebec, involved the consideration of the problem " where can the sea and the inland trade of the St. Lawrence most economically meet? Should the lake propeller (the smaller craft) descend to the lowest possible point to meet the Atlantic ship (the larger vessel), or should the latter ascend to the highest possible point? " The ocean trade was limited to a certain number of voyages between the months of May and December. The number of these long voyages was not to be influenced by the comparatively trifling addition of the ascent to Montreal. It assumed that the same number of ships would do the same business whether they came to Montreal or stopped at Quebec, but this could not be said of the inland voyage. A greater number of inland craft, therefore, would be required to bring down the same amount of produce per annum, if taken to Quebec than if left at Montreal. The Board of Trade of Montreal and many influential citizens endeavoured to induce the Government to resume the important undertaking between 1847 and 1850. In the latter year, the Hon. John Young proposed a plan for the deepening of the St. Lawrence, which was briefly as follows:—

DEEPENING THE ST. LAWRENCE.

The Harbour Commissioners of Montreal should be authorised to undertake the work and to borrow money for the purpose, the interest on which was to be provided by a tonnage duty of not exceeding one shilling per ton on all vessels drawing 10 ft. and upwards, and by the surplus revenues of the Harbour of Montreal, in case the tonnage duty should prove insufficient for the purpose, etc.

The plan was approved and adopted by the Government, Young being appointed a Harbour Commissioner to enable him to carry out his plan. In August, 1850, the St. Lawrence ship channel was placed under the jurisdiction of the Harbour Commissioners of Montreal, who appointed a Board of Engineers to examine Lake St. Peter and report upon the best course to be pursued for the construction of a ship channel, 16 ft. in depth at low water, being 2 ft. deeper than the channel contemplated in 1843 by the Commissioner of Public Works. General William Gibbs MacNeil and Captain John Child, distinguished American civil engineers, and C. S. (later, Sir Casimir) Gzowski, (s) who afterwards built a section of the Grand Trunk Railway, were selected for this important duty. On October 31st, 1850, the engineers' report was received, advising the Harbour Commissioners not to resume operations in the straight cut attempted by the Board of Public Works, but to follow the natural channel which presented no obstructions, but sand and clay, which could easily be removed by dredging. The recommendation was adopted by the Harbour Commissioners, and by the end of season of 1851, the channel had been deepened to the extent of 2 ft. and widened to 75 ft. Young's impulse produced striking results. On November 2nd the s.s. *City of Manchester* was loaded down to 14 ft., the depth on the " flats " then being 12 ft., and steamed through Lake St. Peter without slackening speed. By the summer of 1852, the channel had been widened to 150 ft., and in November, operations for dredging the channel to 15 ft. deep at low water were completed.

Within the same period of time, and for the same amount of money as had been expended on an ineffectual attempt to obtain a channel 150 ft. wide, with 14 ft. water on the straight line, one of 250 and 300 ft. in width, with 16 ft. 2 in. at low water, had been provided through the " flats " by the Harbour Commissioners. The channel had also been improved above that point to the entrance to the Harbour of Montreal so as to give a depth of 15 ft. throughout at low water, the entrance also being deepened to 17 ft. with sufficient width to enable ships to be towed through it.

The harbour engineer, Thomas C. Keefer, C.E., made a survey of the river between Montreal and Quebec, and by the end of 1853 reported the practicability of deepening the channel to 20 ft. at low water, at a comparatively moderate cost, provided a channel at the south side of the river, between Varennes and Lavaltrie, were adopted for improvement instead of the old channel on the north side. By 1858 the channel had been deepened to enable sea-going vessels draw-18 ft. at the lowest stage of water to come up to Montreal. A depth of 20 ft. with a width of 300 ft. was obtained in November, 1865, when the s.s. *Ocean* passed down the river. The completion of the 20 ft. channel marked an important era in the history of the St. Lawrence route. The success of the work amply demonstrated that the St. Lawrence could be made available up to Montreal for navigation by large ships and the marked increase of Canadian commerce showed how imperatively it was required.

WORK OF JOHN YOUNG.

The vision and driving force of the Hon. John Young, (t) had inaugurated this broad and coherent navigation policy which cleared the way for the present development of the Port of Montreal. " I have it in my power," he says, " to show that the present depth of water and the proposed depth is not only beneficial to the highest degree to Montreal as a port, but lies at the very foundation of the future greatness of the city. It is also equally beneficial to the country inasmuch as it lessens the distance from the interior to a seaport 180 miles and by cheapening transport enhances the value of every agricultural commodity exported. I have laboured for several years and have succeeded in obtaining the acknowledgment of this, and former Governments, that the works in Lake St. Peter and the St. Lawrence are not local in their character, but should be considered as Provincial Public Works. Already, indeed, the Government have so far acknowledged this, that a sum of £15,000, has been advanced by the Government for the Lake St. Peter and operations of this year."

(q) Hon. George Moffatt, the first Chairman of the Montreal Harbour Commission held office from 1830 to 1836.

(r) The Repeal of the Navigation Laws in 1849 led to the removal of all restrictions against American vessels from the Great Lakes to the sea in the Reciprocity Treaty of 1854, which was repealed in 1866. The right of American navigation in the St. Lawrence was conceded forever in the Treaty of Washington, 1871.

(s) Among the great engineers associated with the port of Montreal were Sir Sandford Fleming and Sir John Kennedy, the latter having designed and carried out many of the improvements of the present Harbour.

(t) Hon. John Young (1811-1878), Chairman of the Harbour Commission, 1853-78, with two short intervals, and creator of the port, died quite a poor man and his widow was granted an annuity by the Harbour Commission.

Young goes on to say "that it had been very difficult to carry on such work for so long a time without Government aid or security, and in placing the credit of the Harbour Trust in a position only inferior to that of the Government Securities themselves. As bearing on the comparative advantages of the St. Lawrence route to Europe, I should say that it should be borne in mind that it is only ten years since the restrictive laws of Great Britain allowed foreign ships to enter the St. Lawrence; that the entire absence of lights in some parts of the St. Lawrence only tended to increase the bad name of the navigation; that our railway communication with the interior has only been open for three years; (u) that our Canadian canals have never been completed. (v) Nor are there any means of receiving and delivering produce at our inland and shipping ports capable of the least comparison with what exists in American ports; and unless we, as Canadians, are prepared to provide these means, we cannot expect to obtain a share of that trade which it is in our power to command." (w) Canadian transportation routes and port facilities in 1926 present an extraordinary contrast to Young's description of 1859.

The extensive programme of Canadian canals from Lachine to Saute Ste. Marie undertaken in 1840, the construction of the St. Lawrence ship canal in the 'fifties, and the first Victoria Bridge at Montreal in 1860, are striking evidence of the courage, resource and foresight of the Canadas in years of acute commercial depression before Confederation when the population was small and scattered. (x) The granting of bonding privileges by the United States in 1845 drew much traffic from Canadian to American routes. The majority of vessels arriving in Montreal came in ballast; owing to this fact and the British preference for Canadian timber, rates were very high. The repeal of the Corn Laws in 1846 had ensured the adoption of Free Trade in England which means the collapse of the Old Colonial System. Peel's opponents declared that the new policy would drive Canada into the American Union, and they advocated the extension of the Free Trade principle to the colonies as well. In 1849, the year of the "Annexation Manifesto," signed by 325 prominent Montreal merchants urging annexation to the United States as a panacea for Canadian ills, the repeal of the Navigation Laws removed the chief handicap to the freedom of Canadian trade. English Free Trade had practically destroyed the trade of the St. Lawrence. The almost immediate result of the repeal of the Navigation Laws was a reduction in freight rates from Montreal and Quebec to the United Kingdom. (y) It had rightly been predicted that while Free Trade in corn had taken away a large part of St. Lawrence commerce, Free Trade in shipping would restore it. (z).

THE ACT OF 1873.

Through the exertions of the Hon. John Young, an Act was assented to on May 23rd, 1873, granting a loan of $1,500,000 for the completion of the ship channel to a depth of not less than 22 ft. at low water. The Commissioners, on November 2nd, 1874, resolved to deepen the channel from 20 to 25 ft. at lowest water, the 25 ft. channel being completed and tested in October, 1882, by the Allan liner *Peruvian*. In January, 1884, Andrew Robertson, the Chairman of the Board, announced a Government loan of $900,000, at 4 per cent., which enabled the deepening of the channel to 27½ ft. On May 22nd, 1888, the work of deepening the channel was assumed by the Department of Marine and Fisheries of the Dominion Government, after the Harbour Commissioners of Montreal had practically completed the dredging of the same from 11 to a depth of 27½ ft. One of the first moves was the abolition of tonnage dues. (aa) Up to the end of 1887 the Harbour Commissioners of Montreal had expended $295,500 of their own revenues in the deepening of the channel, providing buoy and beacon service, $61,500, and on interest on channel expenditure some $800,000, which, less $37,500, representing a deficit for the year 1887, amounts in round figures to some $1,119,500, due to the Harbour Commissioners. The Harbour Commissioners of Montreal have never been reimbursed this amount.

The 27½ ft. channel was officially opened by the Allen Line s.s. *Parisian* on November 7th, 1888. The 30 ft. channel was commenced in 1899 and completed in 1907. Work on the 35 ft. channel was started in 1910 and at the end of 1925, 48⅓ miles had been dredged, leaving a balance of a little more than 40 miles yet to be dredged to complete the work. (bb)

In discussing the ship channel transfer in 1888 the Right Hon. Sir Charles Tupper, then Minister of Finance, who introduced the Bill, said: "No public body in the country have ever discharged a duty imposed upon them with greater ability or greater success than the Harbour Commissioners of Montreal . . . the Harbour of Montreal has never been chargeable to the extent of a dollar on the revenue of the country." (cc)

Dredging Costs. (dd).

	Cost of dredging. $	Expenditure for plant, shops, surveys, etc. $	Quantities dredged. cu. yds.
Montreal Harbour Commissioners, 1851 to 1888			
Dredging Montreal to Cap à la Roche to 27½ ft. at O.L.W. and from Cap à la Roche to Quebec to 27½ ft. at half tide	3,402,494.35	534,809.65	19,865,693
Department of Public Works Dredging consisting of widening and cleaning up of channel, deepening Cap à la Roche to Cap Charles to 27½ ft. at O.L.W. and dredging at Grondines, Lotbiniere and Ste. Croix, 1889 to June, 30, 1899 ... Project of 1899	839,583.08	486,971.79	3,558,733
Dredging channel between Montreal and Quebec to 30 ft. at lowest water of 1897, also widening to a minimum width of 450 ft. and straightening—			
Fiscal year 1899-1900	100,191.91	265,270.78	1,107,894
,, 1900-1901	136,680.83	287,040.04	2,479,385
,, 1901-1902	185,429.80	479,731.47	3,098,350
,, 1902-1903	255,776.55	277,703.50	6,544,605
,, 1903-1904	276,958.59	308,765.44	4,619,260
Department of Marine and Fisheries. This includes the work below Quebec.			
Fiscal year 1904-1905	311,087.93	277,225.69	2,716,220
,, 1905-1906	431,768.30	317,327.37	4,047,530
,, 1906-1907 (July 1, 1906, to Mar. 31, 1907)	302,677.37	275,003.61	3,001,010
,, 1907-1908	478,209.66	417,390.22	4,831,875
,, 1908-1909	497,686.03	340,861.86	5,896,737
,, 1909-1910	572,950.71	321,375.80	6,354,285
,, 1910-1911	567,838.02	488,248.88	5,600,050
,, 1911-1912	588,697.60	499,799.58	4,509,904
,, 1912-1913	663,229.74	702,071.86	6,929,344
,, 1913-1914	895,235.59	740,664.26	6,140,867
,, 1914-1915	1,036,846.65	549,369.91	6,225,143
,, 1915-1916	976,622.03	809,443.95	8,462,957
,, 1916-1917	1,030,550.60	353,152.12	7,800,555
,, 1917-1918	618,299.69	156,112.57	2,517,376
,, 1918-1919	350,152.92	82,480.60	628,060
,, 1919-1920	422,107.05	132,747.20	517,305
,, 1920-1921	446,134.85	151,422.99	715,895
,, 1921-1922	464,660.74	102,710.14	1,167,100
,, 1922-1923	465,236.80	446,933.08	793,350
,, 1923-1924	550,612.71	130,481.97	1,314,505
,, 1924-1925	557,863.56	333,345.19	1,373,420

Totals: Cost of dredging, $17,434,683.66, plus $10,268,461.52 = $27,703,145.18; expenditure for plant, etc., $10,268,461.52; quantities dredged, 122,816,953 cu. yds.

THE HARBOUR AUTHORITY.

The Harbour Commission of Montreal is a corporation which derives its powers from legislation of the Parliament of Canada. Act 57-58 Victoria, chap. 48, is styled "an Act to amend and consolidate the Acts relating to the Harbour Commissioners of Montreal," and recites in Section 1 that "this Act may be cited as the Montreal Harbour Commissioners' Act, 1894."

Section 3 recites that the repeal of older Acts (ee) "shall not in any way affect the corporate existence of the Harbour Commissioners of Montreal, which, together with all such persons as hereafter become members thereof, shall continue to be the same Corporation, under the same name, as that constituted by the Act of the late Province of Canada, 16 Victoria, chap. 24, continued by the Act of the said Province, 18 Victoria, chap. 143, and further continued by the Act of the Dominion of Canada, 36 Victoria, chap. 61."

There have been various amendments to the first-mentioned Act, viz., 57-58 Victoria, chap. 48, the most important of which is 8-9 Edward VII., chap. 24, which made certain alterations to the boundaries of the Harbour of Montreal and the Port of Montreal respectively. Section 4 of this latter amending Act sets forth:—"The Harbour of Montreal shall be vested in the Corporation, and shall be under its jurisdiction, control and management for the purposes of this Act."

The corporate body, the Harbour Commissioners of Montreal, is the only authority having jurisdiction within the limits of the Harbour of Montreal. Previous to the year 1907, the personnel of the Corporation consisted of 11 Commissioners, six of whom were appointed by the Governor-General-in-Council, the Mayor of Montreal acted ex-officio, and the other four Commissioners were elected, one by each of the following bodies:—the Montreal Board of Trade, the Montreal Corn Exchange Association, La Chambre de Commerce du District de Montréal, and the shipping interests.

(u) The Grand Trunk Railway was incorporated in 1852, the Montreal-Toronto section being opened in 1855.

(v) By 1848 there was a 9-ft. waterway from Montreal to Chicago.

(w) Hon. John Young to Editor of "Montreal Gazette," August 8, 1859.

(x) Lower and Upper Canada had a population of 1,111,566 and 1,396,091 respectively in 1861.

(y) Ocean rates were much lower from New York than from Montreal to Liverpool, e.g. a barrel of flour from New York cost 1s. 3½d., while the rate from Montreal was no less than 3s. 0½d.

(z) Adapted from Brown, George W., The Opening of the St. Lawrence to American Shipping. Canadian Historical Review, Toronto, March, 1926.

(aa) Section 4,51 Victoria chap. 5, reads as follows:—"No tonnage dues heretofore payable to the Harbour Commissioners shall hereafter be levied or collected from any sailing vessel or steamer at the port of Montreal."

(bb) Historical data of Harbour obtained from Mr. P. Fennell, ex-general manager, Harbour Commission, Montreal.

(cc) House of Commons debates, 1888, p. 1281.

(dd) From Department of Marine and Fisheries, Ottawa, 1925.

(ee) One of the oldest Acts on record respecting the Harbour Commission of Montreal bears the following title:—"An Act to repeal an Act therein mentioned, concerning the Inspector and Measurers of Rafts and Scows and the Pilots, thereof, between Chateauguay and Montreal, and for purposes therein mentioned." 6 Wm. IV., chap. 20 (1836).

In the year 1907, by 6 Edward VII., chap. 33, it was enacted that the Corporation should consist of three Commissioners (one of whom should be appointed President), appointed by the Governor-in-Council upon the recommendation of the Minister of Marine and Fisheries, and that they should hold office during pleasure. (ff)

CONSTITUTIONAL PRACTICE.

The practice since that time has been, that upon the resignation of the Government, the Commissioners then holding office have handed in their resignations, and the incoming Government have appointed new Commissioners. Further than this, the Government have no say in the operation of the Harbour of Montreal. The Harbour Commissioners of Montreal do not now issue any debentures to the public. The funds for the necessarily great expenditures which any programme of Harbour extension entails are obtained from the public purse of Canada, and the following method of procedure is followed.

Having decided to their own satisfaction that a policy or programme of extension is necessary, the Commissioners approach the Parliament of Canada for a vote of the required amount of money. The approach is made through the Department of Marine and Fisheries, and is accompanied by a statement of the case, with plans and estimates of the cost. In due course Parliament votes a loan of some millions. Detailed plans, estimates and specifications for the first item of the programme to be undertaken are then prepared and forwarded to Ottawa for approval. With the sanction of the Governor-in-Council, the works are commenced by the Harbour Commissioners. After a month has elapsed, the auditors of the Department of Marine and Fisheries examine the books of the Harbour Commissioners, and certify the outlay of the four weeks. Application is then made to the Government for an advance on loan from the millions which have been voted to cover the expenditure which has taken place. This is duly certified, and a cheque is issued from the Department of Finance to the Commissioners, who thereupon issue a Debenture in favour of the Minister of Finance and Receiver-General in an amount equal to the advance on loan. When a half-year has elapsed, interest is paid on the advances made, and subsequently every half-year. The Harbour Commissioners of Montreal, in spite of the large capital outlay, have always paid their operating expenses and interest on capital.

The above procedure is followed only in connection with expenditure on items of new development, or as it is called, expenditure on capital account, and arises mainly from the fact that the financing is done by the Government instead of by the investing public. With regard to the equally important work of operation, maintenance, and direction of a Corporation which in 1925 had a revenue of close on to $5,000,000, the Commissioners carry on without direction from any higher authority. (gg)

A recent publication says of the Port of Montreal:—"Probably the most thoroughly organised North American port is Montreal. This is a public trust with far-reaching rights. Unless a port authority owns the port and has the authority, it cannot accomplish very much. But at Montreal the moment one steps through the gate into the port area one is under a new government. The port authority maintains its own police force and can make arrests. It can expropriate property required for waterfront developments. It makes its own rates, makes its own laws, and borrows its own money. It owns, operates and controls to the fullest extent. It has been remarkably successful." (hh)

THE MODERN PORT.

The jurisdiction of the Harbour of Montreal extends 16 miles down each bank of the St. Lawrence. (ii) The narrow strip of land stretching along the Montreal waterfront from Point St. Charles to Bout de l'Ile, reserved as a tow path in the early years of the French régime, remains to this day a public trust.

The main harbour consists of the western, central and eastern sections. The western part comprises Windmill Point Basin, the entrance of the Lachine Canal and the Bickerdike Basin. The locks are capable of accommodating vessels 275 ft. in length, of 45 ft. beam and 14 ft. draught. In this section is located the Harbour Commissioners' Elevator "B," with a storage capacity of 3,500,000 bushels and conveyor galleries serving six shipping berths at the rate of 100,000 bushels per hour. This elevator is equipped with two vessel unloading marine towers. Four large coal importing and bunkering plants, operated by private companies, are situated in this section, also two graving docks and one ship yard.

The central section of the port comprises the Alexandra, King Edward, Jacques Cartier and Victoria Piers, all with two-storey steel transit sheds (26 in all) extending the original full length and width of the piers, with electric freight hoists giving access to the upper storeys. The high level piers in this section are 1,250 ft. long, separated by slips 550 ft. wide. Harbour Commissioners' Grain Elevators Nos. 1 and 2 are equipped with vessel-loading conveyors connected with every loading berth in this section.

Elevator No. 1 is the largest seaport elevator in the world. It is 530 ft. long, 128 ft. wide and 202 ft. high, and has a storage capacity of 4,000,000 bushels. Grain can be received at this elevator from lake vessels and barges at the rate of 40,000 bushels per hour; it can also be received from cars at the rate of 36 cars per hour, while it can be delivered at the same time to ocean vessels at the rate of 75,000 bushels per hour.

Elevator No. 2, the first large terminal elevator building constructed entirely of reinforced concrete, is 457 ft. long 100 ft. wide and 200 ft. high, and has a storage capacity of 2,662,000 bushels. It is connected with Elevator No. 1 and can deliver grain over fifteen miles of rubber belting to all of the twenty steamship berths in the central section at the rate of 150,000 bushels an hour.

In the eastern section is included a long and partially-developed length of shore-line, extending from the end of the Victoria Pier to Pointe aux Trembles, and it is here that the future development will largely take place. The high level wharves in this section are being added to by some 700 or 800 ft. yearly. In this section is located Elevator No. 3, 640 ft. in length, 80 ft. in width, and 200 ft. in height, with a storage capacity of 2,000,000 bushels. It is equipped with four car unloading machines, handling 28 cars per hour, and four marine towers with a capacity of 60,000 bushels per hour, where two lake boats can be unloaded simultaneously. It has eight conveyors extending to Tarte and Laurier Piers, where five vessels can be loaded with grain at one time, at the rate of 120,000 bushels an hour. It is expected that the capacity of Grain Elevator No. 3 will be doubled in 1926. Four private coal handling plants are located in this section, and also oil-receiving wharves specially piped, together with the ship-building and repairing plant of Canadian Vickers, Ltd., which has a floating dry dock of 25,000 tons capacity.

COLD STORAGE PLANT.

The Warehouse and Cold Storage Plant is located between the Central and Eastern sections, on the harbour front. This warehouse is 440 ft. long, 110 ft. wide, and 10 storeys high. Ten refrigerator cars may be switched into the plant adjoining the trucking platform; 10 others may be loaded or unloaded from a track outside the warehouse. Motor trucks or teams to the number of 30, all under cover within the walls of the building, may handle goods directly at the trucking platforms. The storage capacity of the entire plant amounts to 4,628,000 cubic feet. The warehouse is built of massive reinforced concrete with brick curtain walls of the most modern designs. Every known modern convenience for efficiency and excellence has been provided.

An air conditioning plant has been installed for use in each of the cold rooms. Four water towers are located on top of the building for the automatic sprinkler system. An artesian well, 1,100 ft. deep, furnishes water of excellent quality of a temperature of 42 degrees Fahr. in summer. The power house and mechanical equipment is situated 50 ft. distant from the warehouse, in a separate reinforced concrete and brick building with three fire walls. All important machinery, compressors, etc., are in duplicate so that in case of accident to one-half of the plant, the other half will be sufficient to carry on the whole of the requirements. An ice-making machine is another important item.

WHARVES AND PIERS.

The extent of wharves and piers in the port is as follows:—

	Lin. ft.	Miles.
For 30 ft. draught or ordinary low water and over ...	28,503	5.3983
For 25 to 30 ft.	15,312	2.9000
Total deep draught	43,815	8.2983
20 ft. depth and under	1,398	0.2647
Total Wharfage	45,213	8.5630

	Berths.
For vessels of 650 ft. in length and drawing 30 ft. of water ...	40
For vessels about 400 ft. long with draught of 25 to 30 ft. of water	36
For vessels 300 ft. long with draught of 20 ft.	17
For vessels 200 ft. long with draught of 10 ft. and over	19

RAILWAYS.

Montreal is the converging point of the Canadian trans-Continental railway systems which connect with the harbour terminal railroad 70 miles in length, owned and operated by the Harbour Commission, and affording access to the harbour to every railroad upon equal terms. Every shed and berth in the harbour, as well as every industry adjacent thereto, are served by this electric railway. The terminal railroad handled 70,000 cars in 1907, the year of its establishment. In 1925, the figures were 251,586 cars; from 1,000 to 1,800 per day. The switching charge in the port is $3.50 per car, the lowest of any port in North America.

(ff) Major George Washington Stephens, the first Chairman of the re-organised Commission, is now President of the Saar Commission, a mandate of the League of Nations.

(gg) Authorities: Mr. M. P. Fennell, Ex-General Manager, and Mr. M. S. Casey, Assistant Secretary, Harbour Commission, Montreal, April, 1926.

(hh) MacElwee, Port Development, p. 52, New York, 1925.

(ii) The Harbour has reclaimed 135 acres of land since 1909.

For the handling of heavy freight, such as locomotives, boilers, machinery, etc., the port of Montreal is equipped with a floating crane, with a lifting capacity of 75 tons at a 54 ft. radius. This crane has a length of 200 ft. and a breadth of 43 ft., with a lift above water of 100 ft. An average of 2,000 lifts is made by this crane during the season of navigation, the heaviest accomplished having been 85 tons. In a normal season, the crane lifts some 10,000 tons. For handling ordinary package freight from ship to shore, and vice versa, the ship's cargo handling tackle is usually employed in the Port of Montreal, but to supplement this, and for situations where such a method cannot be used, the Commissioners possess a fleet of floating cranes ranging in capacity from 5 to 15 tons, and 6 locomotive cranes of 10 and 15 tons lifting capacity.

For the cheaper and more efficient unloading of railway cars of grain, the Commissioners have provided 5 electrically operated car dumpers. These machines, by an ingenious and yet simple arrangement of lifting devices, raise and tilt the car at the same time, and completely empty it of grain at the rate of 7 cars per hour. One of these car unloaders was operated continually during the season of 1923, and 4 similar have been provided in Grain Elevator No. 3.

Prior to the erection of Elevator No. 1 in 1902, grain was transferred directly from lake vessels to ocean liners by means of floating elevators, of which 17 were in operation, each with a capacity of about 7,000 bushels per hour. With the provision of storage facilities in the port and the completion of the largest and most efficient grain conveyor system in the world, containing nearly 15 miles of rubber belting, over which the transatlantic vessels could obtain their grain cargoes at any time, the fleet of floating elevators became a thing of the past. Some of them have been kept in condition, and, in 1922, when the volume of export grain over-taxed the three huge grain elevators, they afforded great assistance in preventing congestion. The floating plant consists of 2 floating elevators, 3 boom spoon dredges, 6 clam shell derricks, 1 drilling and blasting boat, 1 yacht, 7 tugs, 2 testing boats, 39 flat deck scows, 5 dump scows, 1 large coal scow, 1 floating concrete mixer and 1 floating pile driver.

TRAFFIC REGULATION.

The Harbour Commissioners' Police Force, organised in 1913, consisting of a chief, 3 captains and 85 constables, all uniformed and armed, regulates the traffic on the wharves, maintains order and protects life and property within the port. During the season of navigation, constables are furnished to the various shipping companies for special service in protecting cargoes. Carters bringing cargo or removing cargo from the port are checked by this department, particularly those doing business in isolated places in the port. (jj) There is a minimum of pilferage and breakage.

In no port of North America may more efficient labour be found than in the Port of Montreal. Splendid services are rendered by Montreal longshoremen, freight handlers, grain elevator operators and employees in general, who, when the need arises, through the bunching of vessels, work practically continuously until the same are loaded and despatched.

The Harbour Commissioners pay out yearly for salaries and wages approximately $1,500,000. In addition, the weekly pay roll on the docks probably averages over $80,000. (kk)

There has never been a serious fire in the harbour and the port is remarkably free from accidents to ships, crews or longshoremen. A Harbour Hospital with 2 beds and space for 21 additional, financed, owned and operated by the Montreal Harbour Commission for the benefit of its employees and seamen entering the port, was opened in the spring of 1926. A description of the port would not be complete without reference to this new hospital and to the two splendid Sailors' Institutes. Montreal has ever loved a sailor, and in 1862 its interest was crystallised by the formation of the Montreal Sailors' Institute; this succeeded the work carried on by the Y.M.C.A. since 1851, which in turn had inherited the work of the first " Bethel " started about 1836-37. In 1893 the Catholic Sailors' Club was inaugurated. Each of these institutions owns and operates a well-equipped building and co-operates heartily in providing cheerful, homelike and healthful places of resort and recreation to the 165,000 sailors entering the port each season. The principles of temperance and thrift are encouraged, religious services of a simple character are conducted, and the sailor befriended in every way possible.

CONSTRUCTION POLICY.

The constantly increasing trade of the port necessitates an equally constant constructional expansion. During 1925 the port authority expended about $4,593,035.33 on operation and maintenance and an equal amount for additions and improvements. The present facilities include approximately 9 miles of modern deep draught wharf capable of accommodating 100 large ocean steamships; 4 modern fireproof grain elevators with a total storage capacity of 12,162,000 bushels, from which grain can be delivered to 23 vessels simultaneously at the maximum rate of 500,000 bushels per hour, while at the same time inland vessels and railway cars can be unloaded at the maximum rate of approximately 300,000 bushels per hour; a cold storage warehouse of 4,628,000 cubic feet capacity, equipped and constructed on the most modern and hygienic principles, and 18 permanent fireproof two-storey and 8 single-storey transit sheds; an electrified terminal railroad system of 70 miles, operated by 100-ton electric locomotives of the latest design. In addition to locomotive cranes and the usual shore lifts, there is also a large floating crane of 75-ton capacity and excellent facilities for the repair and docking of vessels up to 25,000 tons capacity, while towing, fuelling and fire protection services are well organised. (ll)

The Harbour of Montreal represents, in round figures, an eminently modest and justifiable expenditure of $48,000,000. (mm) It is interesting to compare this figure with the total of £32,964,392 13s. 7d. spent on the great port of Liverpool up to July 1st, 1925. (nn)

The Harbour of Montreal is operated by three Commissioners and an Executive staff consisting of a General Manager, a Secretary and a Chief Engineer.

STEAMSHIPS.

In 1809, the Hon. John Molson launched the *Accommodation*, a steam vessel 85 ft. in length, the first steamer on the St. Lawrence River and the second steam vessel in North America. The *Accommodation* caused him a loss of £3,000. He persevered, however, and built the *Swiftsure* the *Lady Sherbrooke*, and the *Car of Commerce*, these steamboats being available during the War of 1812. The first trip of the *Accommodation*, November 3rd, 1809, is described thus by a contemporary writer: "The *Accommodation* shot out into the current and after a voyage of some 66 hours, of which some 30 hours were spent at anchor in Lake St. Peter (waiting for a favourable tide), reached Quebec with ten passengers." The motto of the vessel was " no wind or tide can stop her." The fares were $8.00 down the river and $9.00 up, the vessel providing the meals gratis.

What is said to have been the first steamship advertisement on the St. Lawrence, and which appeared in the *Canadian Courant*, a Montreal newspaper of that day, reads as follows: " The steamboat will leave Montreal to-morrow at 9 o'clock precisely for Quebec, those wanting to take a passage will make a choice of their birth (sic) and pay their passage money before 8 o'clock to-morrow morning, that a proper supply of fresh provisions may be provided. Fares to Quebec:—

For Passenger	£2 10 0
For Children under 11	1 5 0
Servant with Birth	1 13 4
Servant without Birth	1 5 0

N.B.—60 lbs. weight will be allowed for each full passenger and so in proportion. Way passengers are to pay one shilling per league, and if a meal occurs in the going, not less fifteen leagues, will be gratis, if less, will be charged two shillings sixpence each meal.

Montreal, 4th June, 1810."

This vessel loaded its passengers and freight at Molson's Wharf at the foot of St. Mary's Current, and like other ships of the day, ascended the Current with the aid of horses or oxen.

EARLY MONTREAL SHIPS.

David Munn built the first ships in Montreal about the year 1806, these vessels being from 200 to 350 tons cargo. From 1925 to 1828 no less than 185 ships were built in the Province of Lower Canada. In 1829, Shay and Merritt built the ss. *British America*, 170 ft. long, 38 ft. beam, for John Torrance and Company, as a trading vessel between Quebec and Montreal. In 1830, the s.s. *John Bull*, 182 ft. long, 32 ft. beam, was constructed for John Molson and Company, for Montreal-Quebec traffic. The two boat *Hercules* in 1824, was the first vessel with steam power and without other aid to ascend St. Mary's Current with the s.s. *Margaret* in ballast. In October, 1818, the s.s. *Caledonia* took three days for the voyage from Quebec to Montreal and 42 oxen were required to assist her in ascending the current. John and David Torrance, who in 1826 had placed the s.s. *Hercules* on the Montreal--Quebec route, were the first Canadian merchants to branch out into direct trade with the East Indies and China. (oo)

The first ship to cross the Atlantic wholly propelled by steam was the good ship *Royal William*, the hull of which was built in Quebec and the engines in Montreal. This vessel was launched at Quebec on April 27th, 1831, and was intended for the run between Quebec and Halifax, with freight, passengers and mails. As the service did not pay the boat was sent over to England on August 5th, 1833, laden with 300 tons of

(jj) Description of facilities from Harbour Commission Report, 1925.
(kk) Authority:— Proceedings of Special Committee, Ottawa (Inquiry into Petersen contract), 1925, p. 129.

(ll) T. W. Harvie, General Manager, Harbour Commission of Montreal. " The Christian Science Monitor," Boston, April 16, 1926.
(mm) New Orleans, La., which it is claimed, is the second port of the United States, has expended $48,295,000 on port improvements according to the New Orleans Association of Commerce.
(nn) Authority: Mersey Docks and Harbour Board, Year 1926, Liverpool, January, 1926.
(oo) Adapted from Atherton, W.H., History of Montreal, 1915, Vol. II, p. 575.

bunker coal and seven passengers who paid twenty pounds sterling each for the privilege. Owing to the disablement of an engine it took 25 days to steam from Quebec to London. This ship was also the first to be equipped with water-tight compartments. The *Royal William* had an eventful history. Shortly after her arrival in London she was chartered by the Portuguese Government, a year later by the Spanish Government, and converted into a man-of-war, *Isabella II.* In 1840, the hull was sold to France, the engines being removed and installed in a new *Isabella II.*, which was lost ten years later on the Algerian coast. A brass tablet on the wall of the corridor leading to the Parliamentary Library, Ottawa, bears this inscription:—

> "In honour of the men by whose enterprise, courage and skill, the *Royal William*—the first vessel to cross the Atlantic by steam power—was wholly constructed in Canada and navigated to England in 1833. The pioneer of those mighty fleets of ocean steamers by which passengers and merchandise of all nations are now conveyed on every sea throughout the world."

SAILING SHIPS.

Modern Canadian trade routes developed from sailings in 1819 between the Clyde and Canada by the small Allan Line brig *Jean.* The regular connection maintained for so many years began with the brig *Favourite*, commanded by Captain Alexander Allan in 1825. This vessel was followed by many more small, full-rigged ships, famous in their day, such as the *Britannia*, *Albian*, *Canada* and *Caledonia.* The first two steamers were built in 1852, the *Canadian* and *Indian*, and the second two in 1855, the *Anglo-Saxon* and the *North American.* On this date the first mail contract was entered into. (pp). Some of the Allan boats were the finest crossing the Atlantic, notably the old *Parisian.* (qq) Many sailing ships were built and run subsequent to this date, the last being in service up to the early 'nineties. The best days of the sailing ships were in the 'fifties, 'sixties and the early years of the 'seventies, the days of the China tea clippers and the Australian wool clippers, many of which were built and manned by "Bluenoses." The death blow to sail (rr) as the method of propulsion on the ocean came with the opening of the Suez Canal in 1869 and the general adoption of the compound engine in 1870. (ss)

NOTABLE LINES.

The present Thomson Line commenced with small sailings in the early 'seventies from continental ports, carrying grain or general cargo for whatever port could be secured. This trade was continued by sailing ships until 1880, then by small steamers of about 2,500 tons dead weight. This line was acquired by Cunards (tt) in 1911, who added five new passenger ships between Montreal and London, and later three freight boats between Montreal and Bristol (Avonmouth). All of these ships were lost in the Great War but have been replaced.

The Donaldson Line was inaugurated with an occasional steamer in 1875 and in 1878 a regular fortnightly service was started between Montreal and Glasgow. The bulk of the export trade being in the hands of Scottish Canadians, the steamship services naturally favoured the Scottish ports. Donaldson ships lost during the War have been replaced in this efficient service. In 1917, Donaldsons amalgamated with the Anchor Line under the name of the Anchor-Donaldson Line. (uu)

The combined Anchor-Donaldson-Thomson-Cunard lines operate seven freight and passenger ships and fourteen freighters from Montreal in the summer to London, Liverpool, Glasgow, Avonmouth, Newcastle, Leith, with passenger calls at Plymouth, Southampton and Cherbourg. In the winter the service is maintained from St. John and Portland. The Thomson Line also runs to Hamburg. (vv)

The White Star Line commenced its Canadian business under the chartered name of The Mississippi and Dominion Steamship Company. The first sailings were from Liverpool to Montreal in 1871, the fleet consisting of the steamers *St. Louis*, *Vicksburg*, *Memphis*, *Mississippi* and *Texas*, Boston and Baltimore being the winter ports. A few years later Portland, Me., became the winter port, the passenger vessels calling at Halifax. The fleet was steadily increased and comprised such popular ships as the *Vancouver* in 1884 and the *Labrador* in 1891. In 1909 the White Star Line became associated with the Dominion Line. These companies maintain regular weekly freight and passenger sailings between Montreal and Liverpool in summer and St. John and Portland in winter, and five freighters ply between Montreal and Avonmouth in summer and St. John in winter. A large freight and passenger ship is under construction for the Liverpool service.

The Pacific Ocean service of the Canadian Pacific Railway was established in 1877 with three chartered steamers eight years before the opening of the road. The first three *Empresses* were completed and placed in service in 1891, the first trip from Vancouver and Victoria to the Far East being made by the *Empress of India.* The Canadian Pacific entered the Atlantic trade in 1903, and, as stated previously, acquired the Allan Line in 1916. The Canadian Pacific holds a dominant position on both oceans, including speed records between Canada and the United Kingdom, and between North America and the Far East. Fourteen freight and passenger ships and ten cargo vessels are operated on the Atlantic and four passenger express ships on the Pacific. Two new liners and five freighters for the Atlantic will be completed in 1927. During the War the C.P.R. handled and transported all munitions and supplies from Canada on behalf of the British Admiralty. (ww)

In 1886 regular sailings were established between Canada, Belfast and Dublin by the Head and Lord Lines. (xx). There are also occasional sailings to Rotterdam.

Elder Dempster & Company, who now run to African ports only, handled many tramp vessels between Canada and the United Kingdom from 1891 to 1895, in which year they established regular lines from Montreal to London and Bristol. In 1899, the Canada Shipping Company (Beaver Line) was acquired, which added a service between Montreal and Liverpool. In 1903, however, their entire North Atlantic fleet, consisting of 14 vessels, was sold to the Canadian Pacific Railway. A South African monthly service was inaugurated in 1902, and the broad-minded policy of this Company has been of great benefit in the extension of Canada's trade. There is no return freight from South Africa to Canada, but 50 per cent. of these vessels bring back cargoes of manganese ore from West Africa.

Furness, Withy & Company, Ltd., the well-known British steamship operators, opened an office in Canada in 1893, with a line of steamships from Halifax to Liverpool and London via St. John's, Newfoundland. In 1898, a line was established between Montreal and Antwerp, and, in the same year, the Manchester Liners, Ltd., opened the freight route between the St. Lawrence and Manchester. At present there are fortnightly boats to London and Hull and weekly sailings to Manchester from Montreal and Quebec in the summer and St. John, Halifax and Portland in the winter.

The New Zealand Shipping Company, Ltd., commenced their services between Montreal and New Zealand and Australian ports in May, 1910, with monthly boats from Montreal in the summer and St. John in the winter, the C.P.R. acting as agents for the first year. No return cargo is brought to Canada, the ships returning via England. The Panama Canal route is used and the usual itinerary of ports of call for the New Zealand service are Auckland, Wellington, Lyttelton and Dunedin, the Australian boats calling at Brisbane, Sydney, Melbourne and Adelaide.

CANADIAN MERCHANT MARINE.

The Canadian Government Merchant Marine, Ltd., consisting of Canadian-built, Canadian-owned and Canadian-manned ships, was a direct outcome of the world shortage of tonnage caused by the War. The first sailing was the s.s. *Canadian Voyageur* from Halifax, February 27th, 1919, to the West Indies. The next ship was the s.s. *Canadian Pioneer* from Montreal to Buenos Aires on May 22nd of the same year. There are now 48 vessels in the service on the Atlantic and Pacific under the direction of the Canadian National Railways, one of whose component parts, the Canadian Northern, had operated for some five years the fast passenger ships *Royal Edward* and *Royal George* between Montreal and Avonmouth in the summer, and Halifax in the winter, the first sailing of these Canadian Northern ships being in May, 1910. The *Royal Edward* was later torpedoed in the Dardanelles, the *Royal George* and three cargo vessels being acquired by Cunards shortly before the Armistice. The freight service comprises four boats per month to London and Antwerp,

(pp) Government mail subsidies have gradually been reduced to a basis per pound of mail. Some freight services are still subsidised, notably Elder Dempster and Company, who receive $100,000 per annum for twelve regular voyages between eastern Canada and South Africa; (the Union S.S. Co., of New Zealand, Ltd., receive an allowance from Vancouver to Australia) and the Royal Mail Steam Packet Co., get a subsidy for a service between St. John, Halifax and the West Indies.

(qq) The Allan Line was absorbed by the Canadian Pacific Railway on January 1, 1916.

(rr) At the present time less than six per cent. of the ocean-going tonnage of the world is sail.

(ss) T. S. Brown, writing in 1872 of his impressions of the port of Montreal, says that the following vessels were in the harbour:— 21 ocean steamers, 20 ships, 22 barques, 3 brigs and 4 brigantines and schooners. Only one ocean steamer was over 2,000 tons and two-fifths of the total tonnage belonged to the Allan Line.

(tt) Sir Samuel Cunard, Bart., founder of the Cunard Line in 1840, was a leading merchant of Halifax, N.S.

(uu) Anchor Line boats came to Montreal some sixty years before.

(vv) Robt. Reford Co., Ltd., are the well-known agents for these lines.

(ww) From 1914-18 the Hudson's Bay Company were purchasing agents for the French Government and loaded many ships at Montreal. The Hudson's Bay Company also despatch supply ships from Montreal and Quebec to Hudson Bay each year.

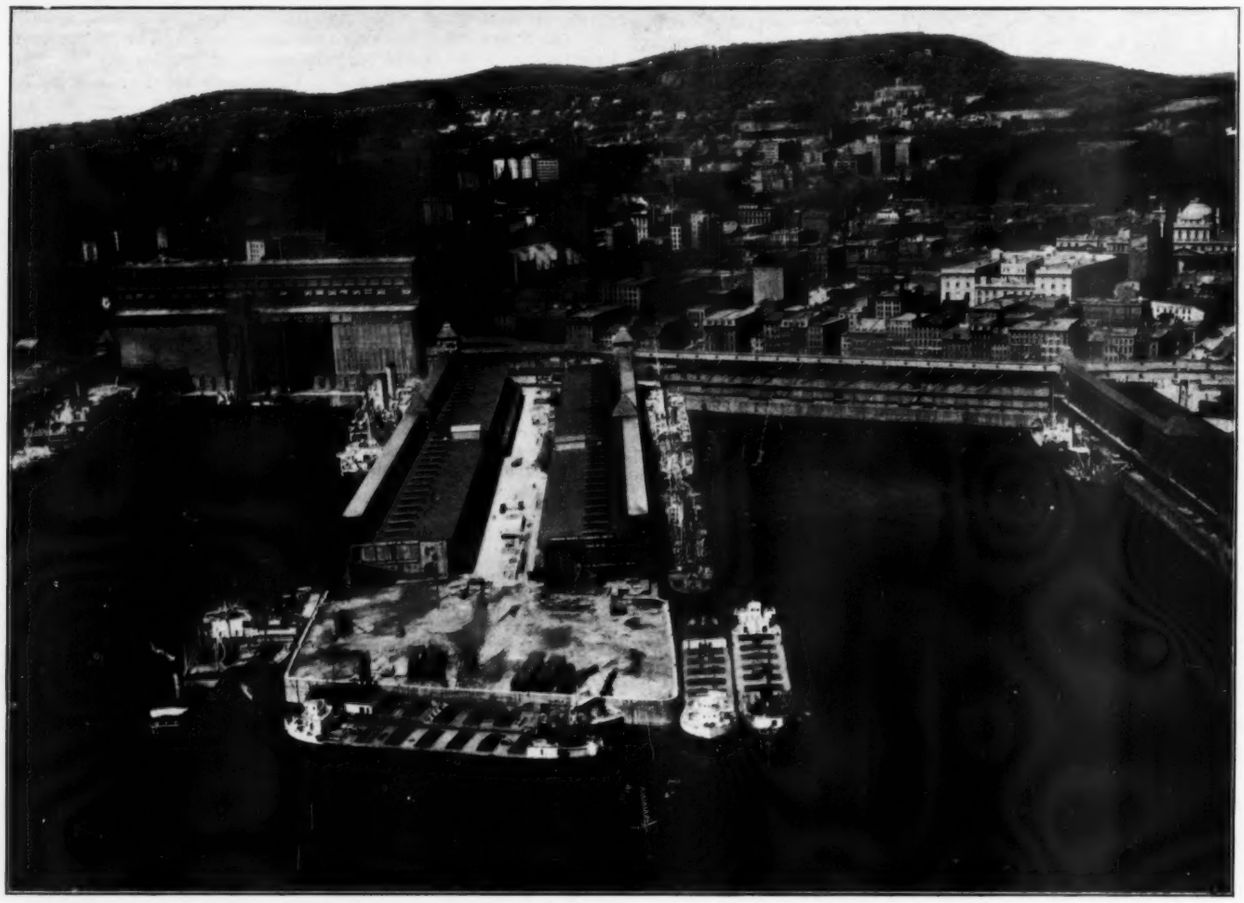
(xx) The agents, McLean Kennedy Ltd., also represent the Houston and Scandinavian-American Lines.

fortnightly to Cardiff and Swansea, every three weeks to Australia, monthly to New Zealand, weekly to the West Indies, fortnightly to Newfoundland, and monthly to Vancouver, from Montreal in the summer. The sailings are divided between St. John and Halifax in winter.

The Houston Line, operating in conjunction with the Clan Line, started its freight service from Montreal to Brazil and the River Plate in 1919.

Recent services are the Scandinavian-American Line between Copenhagen and Baltic ports and Montreal, and a monthly freight service between Montreal, Naples and Genoa, by the Lloyd-Mediterraneo.

started by citizens of Quebec as a result of the American Civil War. Shortly after the outbreak of the Great War, owing to a serious shortage of ocean tonnage, they fitted out and equipped several ocean services, utilising 26 lake vessels as well as acquiring 6 large ocean freight carriers. In 1919, they organised La Compagnie Canadienne Trans-Atlantique, commonly known as the Fracanda Line, between Montreal, Havre and Bordeaux, with two ships, and now operate the Inter-Continental Transports, Limited, with a fortnightly freight service to and from Montreal and Rotterdam, and monthly to Havre. In the winter these ships use West St. John, N.B. The Canada Steamship Lines also maintain a



View of Montreal Harbour, showing Elevator No. 1 and King Edward Pier.

INLAND NAVIGATION.

Inland navigation in Lower Canada had its inception in 1845 when "La Société de Navigation de la Rivière Richelieu" started at the village of St. Charles, Que., with a total subscribed capital of £3,705, to pay for the construction of the s.s. *Richelieu* and the barge *Sincennes*. The subscribers were all farmers who desired better communication with Montreal. The route used was Chambly on the Richelieu River to Montreal via Sorel, at the junction of the St. Lawrence and Richelieu, a total distance of 90 miles. In 1857, the Richelieu and Ontario Navigation Company was incorporated. Passage money between Montreal and Quebec in the early 'seventies was $1.50 first class and $1.00 deck passage. These extremely low rates were occasionally cut when competition was rife. In 1873, the trip to Quebec cost $1.00, including berth, via the s.s. *Quebec* and by the *Canada*, only 75c, also with berth. In 1875, the Richelieu Company and the Canadian Navigation Company running between Toronto and Montreal were amalgamated, making a total of 18 ships in the steamship line between Toronto and Quebec. In 1886, the Company acquired the Saguenay Line steamers. The Canada Steamship Lines were created in June, 1913, and included the following companies: the Richelieu and Ontario Navigation Company, the Northern Navigation Company, Limited, Canada Interlake Line Limited and other lake craft, and the Quebec Steamship Company, Limited. In the spring of 1926, other large lake fleets, dry docks and coal companies were acquired from Mr. James Playfair. The service extends from the Great Lakes to Newfoundland with 24 upper lake bulk freight carriers, 40 lower lake bulk freighters (canal size), 16 package freighters, 19 river passenger steamers and 4 upper lake passenger boats.

The Canada Steamship Lines have been in the ocean business from their inception, if one includes the Quebec Steamship Company, now owned by the Furness Line, operating from New York to Bermuda and the West Indies, which was fortnightly service between Montreal, Charlottetown and St. John's, Newfoundland.

The Clarke Steamship Company run weekly passenger steamers to Newfoundland and Gulf of St. Lawrence ports. The Clarke family were pioneers in the great developments now under way along the "North Shore." They deserve much credit for their enterprise and excellent passenger service. The s.s. *Northland*, placed on the route in 1926, is one of the finest smaller steamships afloat.

Several bulk carrier lines run regularly from Buffalo, Port Colborne and upper lake ports to Montreal with flour and grain (yy). *(To be continued).*

Trials of Steam Tug "Banco."

Designed for Towing Barges on the Thames.

The steam tug *Banco*, designed and constructed under the supervision of Messrs. James Pollock Sons and Co., Ltd., has recently successfully completed her trials on the Humber before being delivered to London, to the order of a well-known tug and lighterage firm. Her principal dimensions are as follows: 83 ft. by 21 ft. 6 in. by 11 ft. 9 in.

The machinery consists of triple expansion surface, condensing engines, about 14 in. by 21½ in. by 35 in. by 24 in. stroke, and oil-fired boiler.

Electric light is fitted throughout, and the current is generated from a 21-2 k.w. generator driven by a 6-7 h.p. Bolinder Beta engine.

A special feature of the machinery installation is the turbo induced draught system, which has proved highly satisfactory and no trace of smoke whatsoever is noticed even when the funnel is lowered.

(yy) Historical data obtained from records of steamship companies, Montreal.

Notes of the Month.

PORT VICTORIA LIGHTING.

Electric lighting has been installed throughout Port Victoria, Spencer's Gulf, South Australia.

CHICHESTER HARBOUR.

A seven-ton steam crane and a 20-ton weighbridge have been installed on the Quay Head, at the Sussex Harbour of Chichester.

UDDEVALLA IMPROVEMENTS.

A new quay under construction at Uddevalla, Sweden, is expected to be in use in 1928. It is a cement structure built for a depth of water up to 26½ ft., 300 ft. long on the west side and 130 ft. on the south-west side of the Bädo peninsula.

NEW AIR SERVICE.

The Finance Committee of the French Chamber has agreed to the allocation of a subsidy of 120,000,000 francs, almost £1,000,000, for 1928, to the La Tocoera Company for the purpose of establishing an air service between France and South America.

MARSEILLES BRITISH HOSPITAL.

At a meeting of the General Committee of the Marseilles British Hospital the executive committee were authorised to lease the hospital and all the effects to the Seamen's Hospital Society of Greenwich at a peppercorn rent for 99 years. The committee is thereby relieved of all financial anxiety in managing the institution of the Seamen's Hospital Society, which has already six hospitals under its management.

BAHAWALPUR IRRIGATION.

The two canals which are to irrigate Bahawalpur territory and a third on the opposite (right) bank of the river for the Punjab districts were opened by Lord Irwin on October 28th. The two canals will convey regular streams of water to the desert area of the State known as Cholistan, constituting the fringe of the Great Indian Desert, and will supply over 1,000,000 acres.

HOBOKEN PIERS.

It is stated that the Municipal Council of Hoboken has unanimously decided upon the sale by auction of the Norddeutscher Lloyd's Hoboken piers, which were seized during the war. Between the town of Hoboken, which has become the owner of the piers, and the U.S. Government, or the United States Shipping Board, which uses the piers, a dispute has been going on for some time because the town was demanding the payment of a higher rent. The town of Hoboken, it is stated, has repeatedly approached Congress with a request for permission to sell the piers to private interests.

NORTH EASTERN WAGONS.

The L.N.E.R. have authorised the construction of 8,615 new wagons at a cost of £1,500,000 to meet the requirements of their freight services during 1928. The whole of the wagons will be built in the Company's wagon works. Included in the programme are 2,000 12-ton covered freight wagons. The remaining types embrace refrigerator vans, rail and timber trucks, cattle trucks, mineral wagons, open goods wagons, and brake vans. Certain of the wagons and vans will be fitted with vacuum brakes so that the L.N.E.R. express goods services may be adequately provided for. The L.N.E.R. have placed a contract for nine new tank locomotives with the Yorkshire Engine Company, Sheffield.

NEWHAVEN PIER RECONSTRUCTION.

The directors of the Southern Railway have authorised an expenditure of nearly £100,000 in connection with the reconstruction of the east pier at Newhaven Harbour, and the work is expected to be finished in two years' time. The new pier will follow generally the same lines as the existing structure, but owing to the nature of the work it will be necessary to employ special pile-driving apparatus for the driving of piles and pile-shooting, while special travelling gantries will be erected for handling the materials required for the reconstruction work.

The existing east pier, which was constructed nearly fifty years ago, is a timber structure, with its lower portion sheeted up to three feet above low water level, the top portion being open. The lower or sheeted portion of the pier acts as a groyne and prevents the sand and shingle from silting up the harbour mouth.

The pier, which has been extended since it was originally constructed, is just over 300 yards long, with a lighthouse at the sea end, and owing to the wastage of the timbering, through exposure to the elements, it has been decided to reconstruct it entirely in reinforced concrete.

AYR WET DOCK.

The inverted or cambered cill at the entrance to the Wet Dock at Ayr has been completely removed, clearing the barrier of 3 ft., which has hitherto existed.

SOUTHEND LOADING PIER.

Facilities at the loading Pier, Southend, which is under the administration of the County Borough, include seven three-ton electric cranes and grabs.

MILWAUKEE IMPROVEMENTS.

The sum of $600,000 has been appropriated for the construction of a double car ferry slip at the Port of Milwaukee, for which contracts are now being let.

BOSTON WAREHOUSE.

A new ferro-concrete warehouse at the dock, Boston, Lincolnshire, and additional railway sidings are being constructed to cope with the traffic. Additional cranes have been added to those already on the dock.

BARROW CRANES.

To ensure the quicker turn-round of steamers, particularly those discharging iron ore and minerals generally, the electric luffing cranes of 7 tons capacity complete with grabs, will be erected early in 1928 on the south side of the Ramsden Dock Basin.

HUDSON BAY ROUTE.

Mr. O. W. Nordin, president of the Gaspé Steamship Company, Ltd., of London and Montreal, has written to the Canadian Government offering to establish a direct steamship service between Fort Churchill, on Hudson Bay, and Newport (Mon.) and Calais, in return for a concession of Crown lands in the Fort Churchill area on which to place Swedish settlers.

JUNIOR INSTITUTION OF ENGINEERS.

At the annual general meeting of the Junior Institution of Engineers held on Friday, November 11th, the following officers were elected for the session 1927-1928:—Chairman: W. M. Hurrell; Vice-Chairmen: C. E. Atkinson and S. H. Holo; Hon. Treasurer: R. L. Kirlew; Hon. Librarian: P. L. Mullings; Members of Council: E. Ambrose, H. S. Rentell, and R. D. West; Junior Member of the Council (under 26): B. J. Axten; Honorary Auditors: F. E. Honman, A. E. Knight, T. C. Morewood and A. J. Wheeler.

ZANZIBAR FINANCES.

In order to adjust the financial situation, the Zanzibar Government has increased the import duties from 10 to 15 per cent., and has also introduced stamp duties. Sir Alfred Hollis, the Resident, has rejected most of the Retrenchment Committee's proposals, including the suggested abolition of the Bububa line, amalgamation of departments and reduction of the administrative staff. The Bububa line is a light railway seven miles long, and is the only railway in the island, running from Zanzibar town to Bububa.

PORT FACILITIES AT NORRKOPING.

The Department of Overseas Trade has received from His Majesty's Consul at Stockholm a report giving particulars of harbour facilities and details of charges on vessels (including stevedoring rates and a pro-forma account), and on goods landed, which has been furnished by the British Vice-Consul at that port.

A statement, giving complete details, has been circulated to steamship owners and brokers on the Department's Special Register, and copies may be obtained by companies of British origin, capital and control, upon application to the City office of the Department (Shipping and Transport Section), 73, Basinghall Street, London, E.C.2.

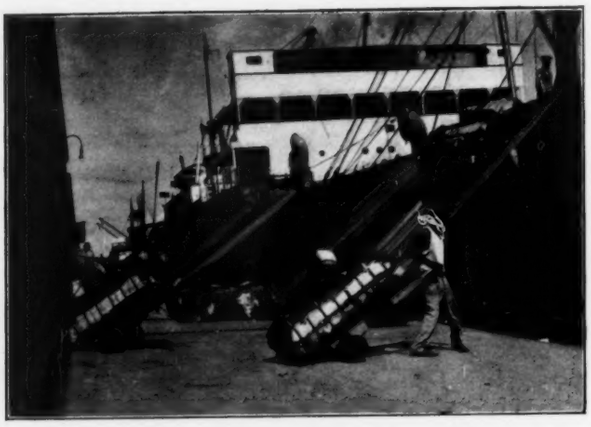
OAKLAND DEVELOPMENT.

The Oakland Municipal Air Port, Oakland, California, has a total area of 825 acres, with a length east and west of 7,215 lineal feet. The length north and south is 8,330 lineal feet. The air distance to the Oakland City Hall is 6½ miles. The running now available is 7,000 ft. long, 600 ft. wide at take-off end and 300 ft. wide at other end. The area now levelled and graded and available for commercial planes is 2,500 ft. by 1,800 ft. in addition to runway used for long flights. The facilities for which contracts have now been let, or will be shortly let, comprise: two steel hangers, each 90 ft. wide and 300 ft. long, accommodating 25 planes. The administration building is 42 ft. by 60 ft., with weather-observing station, quarters for hospital, air mail and aviators, lighting of airport flying field, drainage and field, gas and oil facilities and staff equipment.

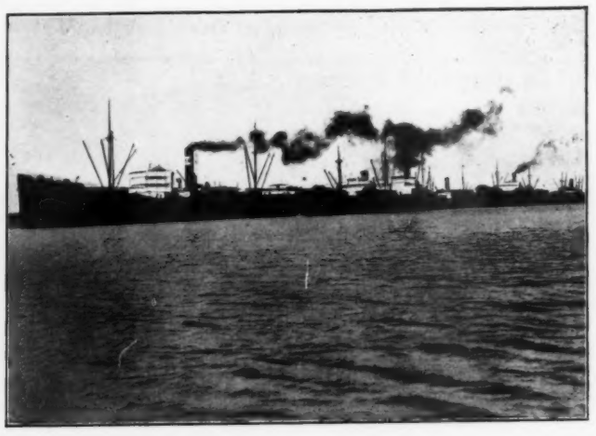
Development of Corpus Christi.

New Federal Deep Water Port shows Notable Growth of Trade.

By VANCE GRIFFITH.



Loading Cotton consigned to English Ports.



Cotton Fleet in Harbour at Corpus Christi.

COMPLETING the first year of its official existence on September 14th, the $5,000,000 Federal deep water Port of Corpus Christi, Texas, has established a new record in regard to the handling of cargo by so new a port, and it has grown and developed with a rapidity that is without precedent in maritime history.

A grand total of somewhat more than 260,000 tons of cargo has moved down the ship channel and out to the Gulf of Mexico during the first twelve months that the port has been in active operation. These figures were compiled under the supervision of J. L. Boyd, Director of the Port.

Of this unprecedented amount of cargo that has been lifted in so short a space of time, about 200,000 tons consisted of oil from the great tank farms located at Ingleside and directly on the ship channel. The remainder of the total tonnage was handled at the wharves and docks alongside the turning basin at the port proper.

By far the most important of all products exported during the past year was the cotton that had been produced in the fertile fields of the South Texas Gulf Coastal country. Approximately 100,000 bales of this fleecy staple was shipped during the first year of operation. It was consigned to practically every section of the world. Over 100,000 more bales is now compressed and awaiting shipment.

The remaining tonnage handled at the port site consisted of 16,000 tons of cotton seed cake and proportionally smaller amounts of cotton seed meal and hull fibres. While some of the imports came from European ports, the majority were handled by the Moore and McCormack lines from the Atlantic seaboard and were made up of ammunition, canned goods, iron and steel products and various miscellaneous commodities.

The total number of sailings from the Port of Corpus Christi during the year which has just passed amounted to 125 vessels, and 75 of them were from Ingleside. Of the remaining 50 vessels, 32 were American ships, exclusive of six Moore and McCormack freighters, three Swedish, two German, two Dutch, one Danish, one British, one Italian, one Norwegian and one Spanish. Their respective destinations covered almost every section of the globe.

It seems only a brief space of time, those twelve fleeting months, since the Port of Corpus Christi was officially ushered into existence with the greatest celebration and jubilee that the South Texas Gulf Coastal country has ever witnessed. The mounting tonnage handled in this short time may well be accepted as evidence of the need for a deep water port at Corpus Christi.

The creation of this deep water harbour made a substantial outlet from which to export the products from an unusually rich territory. This area, which is directly served by the port, now reaches east and north of Corpus Christi to Guero and a considerable distance beyond Victoria, north of San Antonio for many miles, west for one hundred miles beyond Del Rio, and south to include the magic valley of the Rio Grande from Brownsville to a vast distance beyond El Paso.

When the Port of Corpus Christi was opened to the waiting commerce of the world it brought water transportation from one hundred to two hundred miles nearer this area than formerly was the case through other of the older and longer established Texas ports. With the recent regular steamship service inaugurated between Corpus Christi and the Atlantic seaboard through the efforts of Robert Driscoll and Roy Miller, Corpus Christi is in a position to assure this area, which it will directly serve, of an annual saving in costs of transportation that will total many millions of dollars.

While it is not yet operating on as vast a scale as the Transatlantic steamship service, and while its effect up to the present time has not been so far-reaching, this coastwise service directly between the port and the Atlantic seaboard is recognised as one of the outstanding and one of the most important phases of development in the history of the first year of the Port of Corpus Christi.

Operated by Moore and McCormack Inc., this coastwise service was inaugurated on the 15th of last July, when the *Commercial Pathfinder* arrived in Corpus Christi from Philadelphia, bringing a varied cargo of merchandise to different importers, wholesalers and jobbers in Corpus Christi and the Corpus Christi trade territory. Since that time this coastwise service has been operating on a semi-monthly schedule, and it offers an immense saving in transportation costs to importers of the south and south-west sections of Texas.

It was only a short time after this service started its active operation and the sailing from Philadelphia became assured that the firm of Moore and McCormack completed their arrangements to tap the Mississippi watershed by making successful negotiations with the Mississippi Warrior Barge Service for shipping freight from St. Louis, East St. Louis, Granite City, Memphis and other points along the river to the Port of Corpus Christi.

According to these arrangements, which are now in force, freight for South Texas importers originating at these points can be delivered to ship side in New Orleans by the Mississippi Warrior Barge Service. As the coastwise vessels plying between the Atlantic seaboard and the Port of Corpus Christi have New Orleans as a regular port of call, this freight is loaded directly on their ships and transported thence direct to Port Corpus Christi.

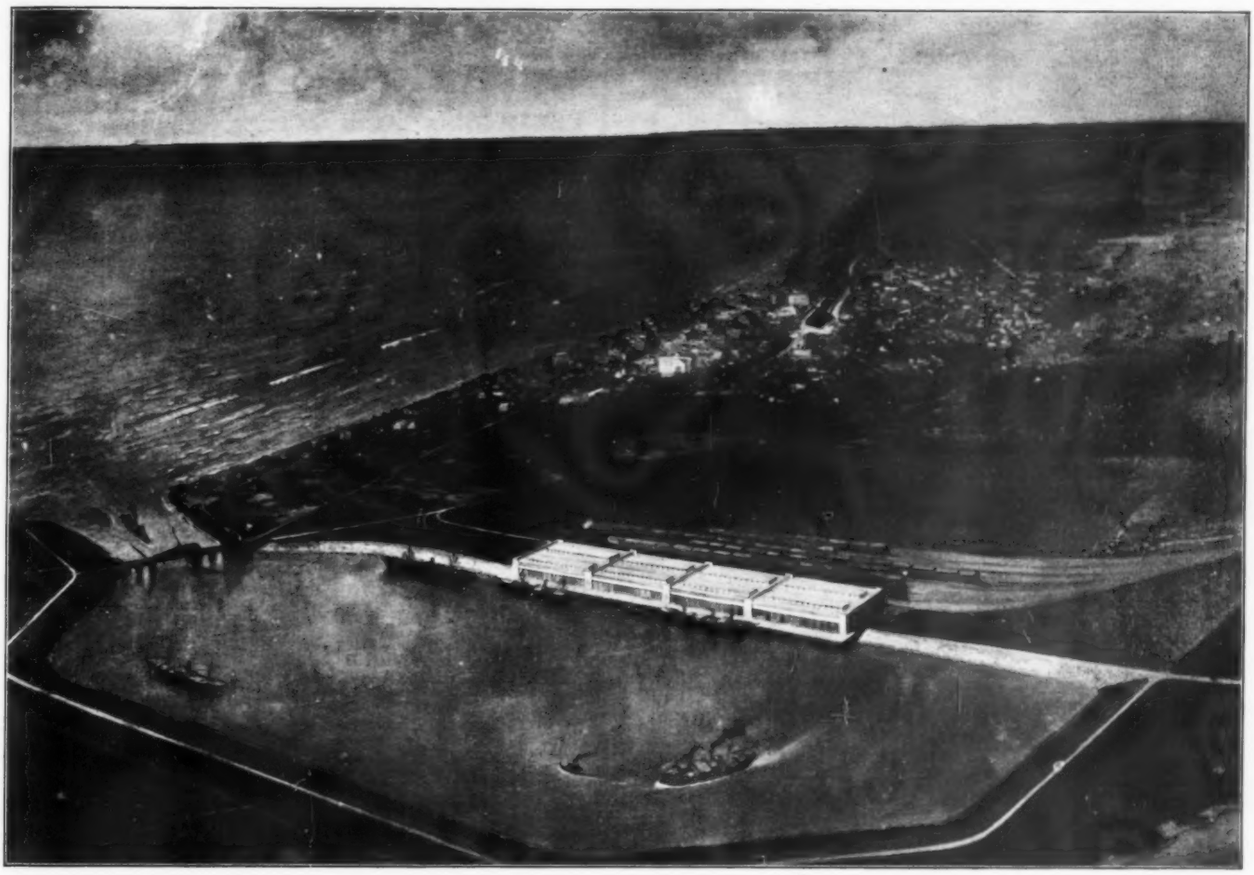
In addition to importing vast quantities of manufactured materials and exporting numerous commodities, it is expected that cotton will be the most important of all products to be handled at the Port of Corpus Christi, and officials of the Navigation Commission of Nueces County were amazed at the amount of the fleecy staple that has already been exported from the port.

The first indication of the vast amount of South Texas cotton that would be handled through the deep water Port of Corpus Christi during the 1927 cotton shipping season came when officials of the Texas Farm Bureau Cotton Marketing Association announced that they would concentrate at least 50,000 bales of cotton at the port site for exportation to the foreign markets of the world, and officials of that organisation signed a contract to that effect. The cotton to be concentrated would come from 38 South Texas counties.

Hard on the heels of this announcement of the Texas Farm Bureau Cotton Marketing Association, representatives of the All-Russian Textile Syndicate Inc., following a thorough inspection of all the shipping facilities and the sources of supply, stated that they would export at least 50,000 more bales of cotton from the new port.

This statement was made by G. S. Thomashevsky, manager of the Southern Department of the All-Russian Textile Syndicate, Inc., and soon after that one of their boats the *ss. Leersum* arrived in the turning basin. It immediately and as rapidly as possible took on a load of 14,000 bales of cotton before it sailed to its destination at Murmansk, Russia.

While thousands of bales of cotton have been loaded aboard vessels of foreign register, the larger portion of it has been loaded on the steamships of the United States Shipping Board, the operating branch of which is the Merchants' Fleet Corporation, which is headed by Major-General A. C. Dalton.



General Lay-out of the Texas Port of Corpus Christi.

Making a tour of inspection of the Port of Corpus Christi only a few weeks before it had completed the first year of its existence, Major-General Dalton stated that Corpus Christi was in the midst of the greatest era of growth and prosperity in its entire history and that the $5,000,000 deep water harbour was destined to become one of the most important parking places for steamships in the entire south.

At the conclusion of his careful inspection, Major-General Dalton declared that he was very much pleased with every phase of the deep water port, and he assured officials of the Nueces County Navigation Commission that the Merchants' Fleet Corporation would send as many Shipping Board vessels to Corpus Christi as would be necessary to handle any amount of cargo destined for European ports.

In the first twelve months that the Port of Corpus Christi has been functioning, many new and important industries have been growing up around it, and it is responsible for a great amount of building and construction, some of which has been finished and some of which is still in the process of construction.

One of the most important pieces of construction was the building of the Aransas Compress, which is located right at the port site. While work is still in progress on this huge project, the seventh compartment has recently been completed and gives the new compress a total of 372,000 square feet of floor space. It will now accommodate in excess of 50,000 bales of cotton. It is equipped with two high density presses which, when manned by competent crews, are each able to turn out cotton at the rate of one hundred bales per hour. It is this compress that is handling the cotton of the Texas Farm Bureau Cotton Marketing Association.

Then the Port Compress Company recently completed its large expansion programme. It enlarged its warehouse from 183 ft. by 750 ft. to 260 ft. by 1,400 ft. This expansion gives the Port Compress Company storage capacity for about 45,000 bales. There is sufficient trackage alongside its platforms where 75 cars may be stored.

Another improvement for which the port is directly responsible is the construction of a $132,000 warehouse by the Corpus Christi Warehouse and Storage Co., Inc. This project is located on land leased from the Navigation Commission and is but a short distance from the turning basin. When completed it will afford storage facilities for jobbers and wholesale dealers all over South Texas as well as for manufacturers and for distributors in other sections of the country.

Now that the Navigation Commission has secured the establishment of a responsible steamship service from the Atlantic seaboard and are negotiating for the establishment of a line from the Pacific Coast, they believe that merchants, jobbers and others receiving goods in the direct territory served by the port will take advantage of the tremendous saving in transportation that can be offered to them.

Just as it surpassed engineering records in its initial construction, the $5,000,000 Federal Deep Water Port of Corpus Christi is likely to break all established records in regard to the securing of tonnage by a new port. Officials of the Nueces County Navigation Commission, headed by Robert Driscoll, are working constantly for the future development of the port, and they are pleased with the progress it has made and the manner in which it has demonstrated that its original construction was an economic necessity.

Dairen Facilities.

Installations in Progress at South Manchurian Port.

Extensive improvements are in course of progress at the Port of Dairen, South Manchuria. At present there is a water area within breakwaters of 3,135,000 square metres and a total length of breakwaters of 13,439 ft. There are three piers and three wharves, beside one inflammable goods pier.

Berthing quay length is 14,293 ft., and berthing accommodation comprises 37 berths for vessels of 2,000 gross tons to 30,000 gross tons, two 5-ton floating cranes, five 5 to 45-ton portable locomotive cranes, three 1½ to 3-ton semi-portal cranes. There is a dry dock, 440 ft. 6 in. long, 51 ft. wide at bottom, and 18 ft. on sill.

There are six coaling berths and three jetties for coaling vessels, with delivery capacity of 200 tons per hour, car dumper with delivery capacity of 1,800 tons per hour, belt conveyors 900 tons per hour.

It is anticipated that the fourth pier now under construction will be completed in 1930. A coal pier with car dumper with delivery capacity of 1,800 tons per hour and belt conveyors to handle 900 tons per hour will also be ready for use about the same time.

The Port of King's Lynn.

Modern Equipment in Old-World Maritime Centre.

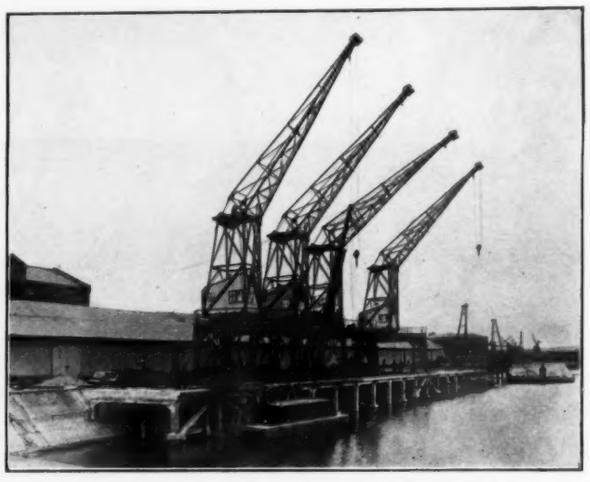
HISTORY.

The old-world town of King's Lynn, situated in the south-eastern corner of the Wash may justifiably take a place among the ancient ports of England, for a thousand years of commercial and maritime activities have marked the history of this Norfolk harbour. Amid monastic relics and architectural beauties, the port retains the touch of ages and yet bears the impress of modern developments.

Two Vessels discharging Cargo alongside Berth.

Here and there in streets along the haven are mediaeval mansions and extensive vaults once filled with choice wines of Portugal and Spain. Many of these old houses have sheltered bygone notabilities, and one in Nelson Street was the home of Gavin Hamilton, the explorer, and in St. Margaret's Lane nearby is the half-timbered warehouse of the Hanseatic League, held by them from the 13th to 18th century. Many, indeed, have inspired modern writers to well-known works. Thus Sir Walter Besant in "The Lady of Lynn," writes of the Jacobean mansion on the north side of St. Margaret's Vicarage.

In King Street is the elegant Custom House, erected in 1683 as an exchange, by Sir John Turner. Nearly opposite, at the corner of Purfleet Street, lived Thomas de Melchbourne, who built a resplendent galleon for Edward II. King Street is full of noble mansions and towards the end is St. George's Guildhall, afterwards a theatre, wherein Shakespeare's own company played, now a warehouse. The town wall, with outer ditch, and parts of these defences still remain. The New Conduit Street is Vancouver's birthplace, now the Friends' Meeting House, which body purchased it from the family. Captain George Vancouver left it when a boy of 14 to sail with Cook, and eventually gave his name to that part of Canada to-day known as Vancouver Island, and to the famous port of Western Canada.

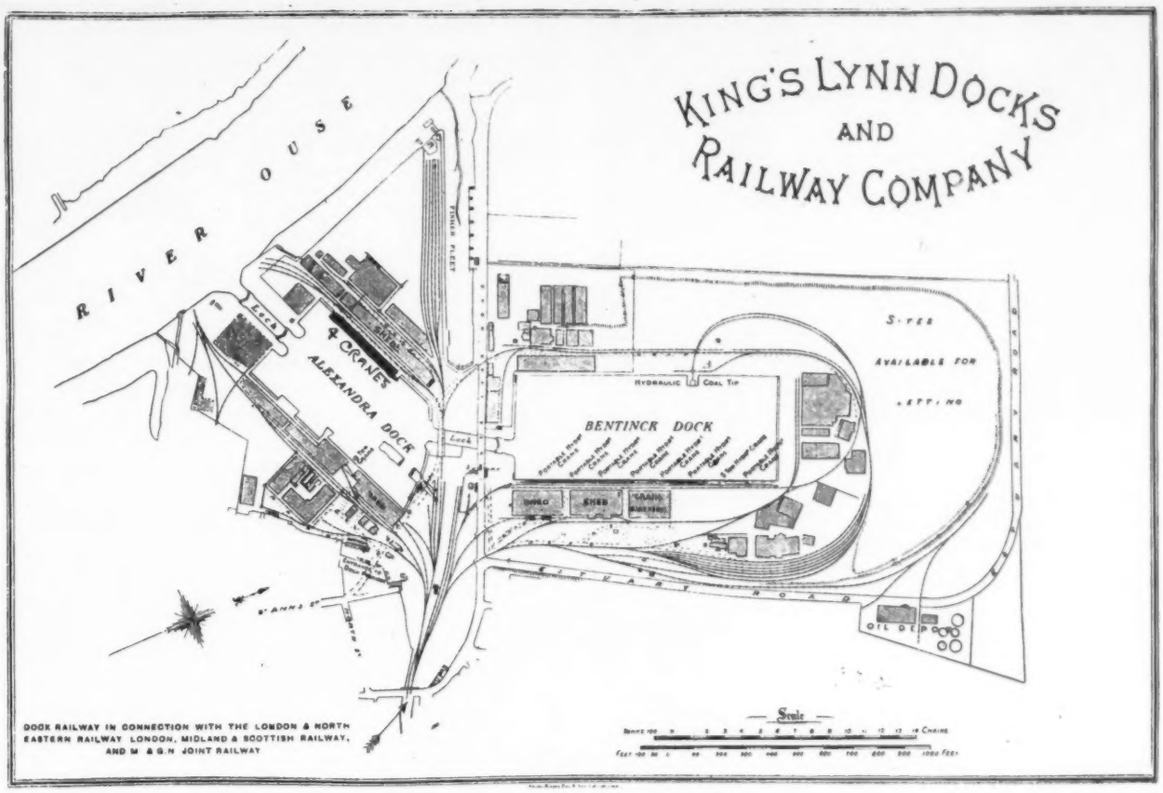


Battery of Electric Cranes on Reinforced Concrete Quay, constructed upon the sloping side of the Alexandra Dock, the older of the two docks at King's Lynn.

TOPOGRAPHY.

The Port of King's Lynn is located at the south-east corner of the Wash, two miles from the mouth of the River Ouse. The meeting place of many roads leading to all parts of the Kingdom, accessible to the Continent and with the advantages of its location on a river, it is not surprising that King's Lynn should have maintained its reputation as a port for so many centuries. The approach channel is lighted, enabling shipping to pass by night or day. There are 1,000 yards of quays along the river, with rail facilities and spacious warehouses. The authority is the King's Lynn Docks & Railway Company, and the docks have a water area of about 17 acres and quayage of one mile. They are equipped with

Aerial View of the Alexandra and Bentinck Docks, King's Lynn.



Map of the Docks and Railway at King's Lynn.

hydraulic cranes, coal tip, warehouses of over 30,000 tons capacity, and three lines of rails along quayside, giving direct access to the London Midland & Scottish, London & North Eastern and Midland & Great Northern Joint Railways. In addition to coastal services, steamers ply regularly to and from Holland, Germany, Belgium and Sweden. King's Lynn is the nearest East Coast port to Birmingham, and the great industrial centres of the Midlands, being their natural gateway to the Continent.

ALEXANDRA AND BENTINCK DOCKS.

The Alexandra Dock is approached from the river through a lock and a second links it with the Bentinck Dock. The width of the outer lock at water level is 50 ft., and at the top of the rounded invert 45 ft. The depth of water on sill is 25 ft. at ordinary spring tides and 18 ft. at ordinary neap tides. There is a hydraulic coal tip in the Bentinck Dock which ships coal at a rate up to 150 tons per hour. There are also hydraulic cranes of 1½ to 5 tons capacity, and electric cranes of 1½ to 3 tons capacity. There is a 15 ton hand crane for heavier lifts. Shipment of coal may be handled expeditiously, and there is considerable siding accommodation. Extensive warehouse space is available for the storage of grain, sugar, and general cargo. There is good road access to the greater part of the dock estate, whilst sites are available for the development of industries requiring close proximity to the docks. Beside canal connections, there is good communication to the Eastern Counties and Midlands. Other facilities include bonds for wines and spirits, timber, storage grounds and a depot for sea-borne oil. *The Conservator* is a powerful tug, owned by the Conservancy Board.

An impression of the relative topography of King's Lynn may be gathered from the fact that a 100-miles radius includes London, Oxford, Peterborough, Cambridge, Norwich, Birmingham, Sheffield, Derby, Leicester, Northampton and the Nottingham, Erewash Valley and Barnsley coal districts. King's Lynn is also the nearest port on the East Coast to the manufacturing districts of Warwickshire and Staffordshire.

The approach channel to King's Lynn is under the jurisdiction of the King's Lynn Conservancy Board, and is well lighted with gas buoys and beacons, so that vessels can enter or leave the docks by night. There is a good safe anchorage for vessels in Lynn Roads, a few miles from King's Lynn.

DUES AND RENT.

Dues and rent on vessels entering King's Lynn are as follows:—

For every vessel with a cargo to or from any port or place in the United Kingdom, the Isle of Man, or the Channel Islands, including rent for 14 days from time of entrance dues, per net registered tons: 6d.; rent after 14 days per ton per week gross tonnage: 1d.

For every vessel with a cargo to or from any port or place on the West Coast of Europe, between the Skaw in Denmark and Ushant in France, including rent for 14 days from time of entrance: 1s.; rent after 14 days per ton per week gross tonnage: 1d.

For every vessel with a cargo to or from any port or place between the North Cape and the Skaw, between Ushant and Gibraltar, or in the Baltic Sea and Gulfs of Finland and Bothnia, including rent for 14 days from time of entrance, per ton, net register: 1s. 4d.; rent after 14 days per ton per week gross tonnage: 1d.

For every vessel with a cargo to or from any other port or place in Europe, or on the East Coast of North America, or from any other port or place, including rent for 14 days from time of entrance, per ton net register: 1s. 6d.; rent after 14 days per ton per week, gross tonnage: 1d.

The S.S. "Poldiep" alongside Quay at Alexandra Dock.

For every vessel to or from any port or place on the East Coast of England entering or using the docks for the sole and exclusive purpose of taking in or delivering coprolites, ballast, gravel or sand, per ton, shipped or delivered: 2d.; rent after 14 days per ton per week, gross tonnage: 1d.

For every vessel entering and leaving the docks without delivering or loading a cargo, including rent for 14 days from time of entrance, per ton nett register: 6d.; rent after 14 days per ton, per week gross tonnage: 1d.

Vessels lying up and not having discharged a cargo in the docks, including rent for 14 days from time of entrance, per ton gross register: 6d.; rent after 14 days, per week gross tonnage: 1d.

Vessels arriving light to load coal per ton, net register: 6d.; rent after 14 days, per ton per week gross tonnage: 1d.

Vessels loading coal, having discharged a cargo in the docks, per ton net register: 4d.; rent after 14 days per ton per week, gross tonnage: 1d.

In cases where a vessel discharges a cargo in the docks and takes a cargo out, one half of the outward dues are charged, this does not apply to vessels loading coal.

Lighters or river craft are charged 8d. for every 10 tons of goods on board with a minimum charge for lighters of 1s. 4d.

Dues payable to the King's Lynn Conservancy Board by all vessels entering the port are as follows: Roaring Middle Light, ¼d. per registered ton; Channel lights and consolidated due per ton of cargo, delivered or shipped, 3¾d. There are other dues applicable only to grain exported, which total 1d. per quarter. Regular traders receive certain concessions.

Towage rates for the King's Lynn Conservancy Board's tug are as follows:—Assisting steamers from Roads to Lynn, 4d. per register ton. Vessels arriving part loaded are charged proportionately, but not less than two-thirds net register. The rate of docking only is 2d. per register ton, undocking 2d. per register ton; sailing vessels, oversea, 1s., coastwise, 9d. Minimum for steamers £5, for sailing vessels £3.

DISTANCES FROM CONTINENT.

Distances of certain Home and Continental ports from King's Lynn by sea are as follows:—Amsterdam, 220 miles; Antwerp, 210 miles; Bremen, 340 miles; Copenhagen, 575 miles; Gothenberg, 465 miles; Grangemouth, 380 miles; Hamburg, 360 miles; Harberg, 360 miles; Harlingen, 190 miles; Hull, 70 miles; Leningrad, 1,260 miles; London, 190 miles; Marseilles, 2,200 miles; Newcastle, 166 miles; Riga, 1,020 miles; Rotterdam, 180 miles; The Texel, 178 miles and Tonning, 120 miles.

Port of Southampton Topics.

THE A.C.L. AND SOUTHAMPTON.

The announcement that the Federal Government of Australia had decided to dispose of the Commonwealth Line of steamers, did not come as a surprise in Southampton shipping circles in view of the finding of the committee appointed to inquire into the matter that the hopes entertained in regard to the line had not been realised, and its recommendation that the concern should not be retained as a direct Government activity. Southampton has benefited considerably from the Australian Commonwealth Line. Ever since it began its service between Brisbane, London and Hull, the Hampshire port has been its British port of passenger disembarkation. The vessels have carried third class passengers only, but frequently as many as 600 passengers have been landed at Southampton from Australia.

WHY EXTENSIONS ARE NEEDED.

When the final statistics of Southampton's dock and harbour activity are completed for 1927 it will be found that the year has been one of unprecedented progress for the port. This fact was disclosed by no less an authority than Mr. G. R. Newcombe, the recently appointed Dock and Marine Manager of the Southern Railway, at the municipal dinner the other day. Mr. Newcombe, basing his contention on the returns of port traffic for the first ten months of the year and the schedule of sailings and departures for the two remaining months, said that there was every prospect of the tonnage for the year exceeding 31 million. The gross tonnage up to the end of October was 26,000,000, which in itself is equal to the year's tonnage last year, when a record was established. To realise what exactly these figures mean in terms of port progress it must be mentioned that when the present owners took over the docks in 1892 the tonnage was less than two and a half million per year. Both in cargo and passenger traffic the figures are increasing, and the indications are that 1928 will be an even better year than this one for the port. Since 1892 the cargo trade and passenger traffic have developed in almost identical ratio. It is small wonder that the Southern Railway Company are pushing ahead as fast as is possible with the big dock extension scheme. The preliminary work in connection with this, Mr. Newcombe admitted, was slow. A lot of ground had to be prepared for the contractors to work on, but once this has been accomplished, progress will be much more rapid. The new docks are absolutely necessary, for the present accommodation is full to capacity.

ACCOMMODATION OUTGROWN.

It may be mentioned here that one of the most interesting features of the development of cargo trade at Southampton is the great increase in the timber trade. This increase has indeed somewhat surprised those who held the most sanguine expectations about it. Despite the fact that new storage space was provided for timber early in the present year, the whole of the special quayside accommodation has been utilised to its fullest extent. There has also been evidence of developments at the Town Quay recently. The Coast Lines have found it necessary to secure additional warehouse accommodation to meet the demands of their trade at the port. The provision of this accommodation, which is required in connection with their East Coast trade, has been considered by the Harbour Board, who are contemplating improving the water depth along one portion of the quay and installing cranes for the work.

GERMAN LINE'S DEVELOPMENT.

The schedules of various shipping companies for next year indicated that more vessels are being allocated to Southampton, and that larger ships, as they are delivered from the builders, will be put on the Southampton service. It is plain, for instance, that the North German Lloyd will be developing their operations at the port. From the new schedule it is gathered that the service by cabin steamers, experiments in connection with which were made during this summer, has been definitely established for next year. These vessels will not only call at Southampton on the outward passage to America, but will also visit the port on the return voyage. In effect, this means there will be 23 extra callings by ships of the N.G.L. at Southampton next year. When next season's shipping is in full swing, the North German Lloyd will have a succession of ships to the port, a total of nearly 50 sailings and departures having been arranged. And, it is confidently anticipated, that in time Southampton will be reinstated as a port of call for services in addition to that connecting with America.

A BUSY WINTER.

Dock activity in Southampton always experiences a heavy slump during the winter owing to the fact that the port is primarily concerned with the passenger trade, but that slump this year will not be so heavy as is usually the case. The addition of two Leyland liners—*Devonian* and *Winifredian*—to the Red Star service will enable that line to maintain a practically usual schedule. This is the first time, incidentally, that any Leyland liners have been south for winter work. The Cunard programme is also a big one. In November they had seven ships out to New York as well as sailings to Canada. In December the line will have eight sailing to America.

THE OVERHAUL SEASON.

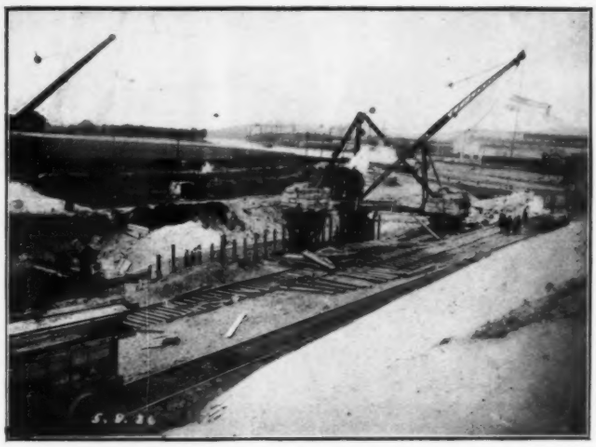
In the matter of employment, also, the winter will be better for local shipyard workers than for many years. The ocean-going liners are lying up for periods for their annual overhaul, and from the latter part of November until the end of February work on them will provide employment for several thousand men. A vessel of the size of the *Majestic* will absorb from 1,000 to 1,200 men during the five or six weeks she is in port. For the overhaul of the "Big Six," the 60,000-ton floating dry dock will be used, and it has been restored to its accustomed position after an absence of a few weeks while its bed off the Town Quay was dredged. Almost all the work will be undertaken by Messrs. J. I. Thornycroft and Co., and Messrs. Harland and Wolff, Ltd. Constructional work of the six sea-going destroyers for the Chilian Navy, in progress at Woolston, is also providing work for men of shipbuilding trades.

BOULOGNE IMPROVEMENTS.

During 1927 the works embarked upon in the interior port during last year were completed. It is anticipated that the extension and improvement of the maritime station will be terminated towards the end of 1928. It is proposed to close the outer port with a view to extending the Larnot Mole and for the establishment of a north breakwater commencing at La Crêche Point. A mole will also be established in the south port of the roadstead. These important works will be executed in the course of 1928.

LIGHTING OF CONTINENTAL DOCKS.

The Mercantile Marine Department of the Board of Trade have issued a warning to seamen against the dangers in some Continental ports at night when returning to their ships, owing to the unsatisfactory lighting at the docks. The warning states: The attention of all members of the crew is drawn to the grave dangers which exist at night-time in various Continental ports, especially Boulogne, Calais and Dunkirk, owing to the unsatisfactory lighting arrangements of the docks and quays, and at river ports such as Rouen, owing to the strong current. In a number of instances men, when returning to their ship at night-time, have fallen into the docks, in many cases with fatal results.



Dock No. 1, Shieldhall, under Construction.

Discharging Iron Ore by Grabs, Rothesay Dock.

Glasgow Harbour Extension.

Progress of the New Dock.

During the current year the principal work in progress at the Harbour of Glasgow has been the construction of the quay walls of Shieldhall Dock No. 1. This dock is the first of a series of six tidal basins comprised in the Shieldhall Docks Scheme laid out on ground belonging to the Clyde Navigation Trustees on the south side of the River Clyde between Glasgow and Renfrew and having a river frontage of 2 miles. In the Spring of 1924 a contract was placed with Messrs. Shanks and McEwan, Ltd., Glasgow, for the construction of the quay walls of the first dock extending to 1,925 yds., and at this date fully 75 per cent. of the work has been completed. The dock, which is half-a-mile in length and 350 ft. in width, will provide 9 berths for large liners with a depth of 32 ft. at low water or 44 ft. at high water. The quays will be equipped with commodious goods sheds with an ample service of sidings connected with the main railway systems of the country.

SINKING THE MONOLITHS.

For the greater portion of the dock the quay walls are built with a substructure of monoliths, 30 ft. square; of moulded concrete blocks built up from a V-shaped steel shoe which forms the cutting edge for the sinking of the monolith. Four wells, 10 ft. square, are formed in the block-work, and through these the material is removed by grabs operated by derrick cranes, and by this means, together with the application of the requisite loading in the form of cast iron blocks, the monolith is sunk through the ground to the required depth, after which the wells are sealed with concrete. At one part of the dock the nature of the ground is not suitable for the sinking of the monoliths, and the quay walls there are being constructed in an open trench within two lines of temporary steel sheet piling. The super-structure of the quay walls over the monoliths and at the piled trench has been completed and the cope laid for nearly 1,000 yds.

About eight months ago a commencement was made with the dredging of the dock area by the Clyde Trustees' own plant, the dredger cutting its own flotation from the river channel into the mouth of the dock which is set back about 300 ft. from the side of the channel. For about 500 ft. at the end next the river the dock area is now under water.

SPRINGFIELD QUAY RECONSTRUCTED.

At the upper portion of Glasgow Harbour, where the coasting trade is accommodated, Springfield Quay was again brought into use during the year, after reconstruction for a length of about 300 yds. This quay, built about 80 years ago, had become inadequate for modern requirements, and a new concrete wall has been built with timber sheet piling forming the face of the substructure. This work was carried out by the Clyde Trustees departmentally. The opportunity was taken to add to the width of the existing shed by the erection of an annexe in front, and the former steam cargo cranes have been replaced by electric semi-portal cranes of modern type.

For the service of the Trustees principal Graving Dock No. 3, a new 25-ton electric travelling crane has been installed to take the place of the former steam cranes. The new crane which runs on rails the full length of the dock has a vertical lift above cope of 110 ft., and a radius of 73 ft., which enables it to plumb the centre of the dock. The former steam crane is to be re-erected between Nos. 1 and 2 Graving Docks and will be provided with crane rails enabling it to command the whole length of these docks.

The electrification of the pumping plant at the Prince's Dock Power Station, which supplies hydraulic power to the cranes and capstans at the dock, was completed during the year by the installation of the third unit of multi-stage direct-driven pumps, each of which is capable of delivering 400 gallons per minute at a pressure of 800 lbs. per sq. in.

The following data conveys some impression of the scope of existing facilities at Glasgow Harbour:—

QUAYAGE ACCOMMODATION.

I.—RIVERSIDE (NORTH).

Berths.		Lin. Yds.
—	Custom House Quay (above Glasgow Bridge) ...	501⅔
2—4	Bridge Wharf	117
6—8	River Steamers	130
10—46	Channel Steamers' Berthage	1,296
52—70	Finnieston Quay and Large Crane	220⅓
	Finnieston Ferries, Crane and Stobcross Quay ...	1,041
72	Kelvinaugh Quay	129⅔
—	Meadowside Quay	538⅔
—	Merklands Quay	525⅓
		4,499⅔

Area—Land - - - 40.45 Acres.

II.—RIVERSIDE (SOUTH).

Berths.		Lin. Yds.
1—3	Railway Bridge	90
5—35	Channel Steamers	936

Dock No. 1, Shieldhall. Monolith Substructure in Course of Construction.

A further View of Iron Ore Discharging by Grabs at Rothesay Dock.

Discharging Apples at Princes Dock.

37—55	Terminus Mineral Quay	431
57—63	Mavisbank Quay	297
65—83	Plantation Quay	906⅓
85	Graving Docks Quay	121
—	Govan Passenger Wharf	46⅔
—	Shieldhall Wharf	699
—	Renfrew Harbour	159
		3,686

Area—Land - - - - - - 30.93 Acres.
Water (I. and II.) - - - - - 225.19 Acres.

III.—KINGSTON DOCK.

Berths.		Lin. Yds
1—4	North Quay	269⅔
5	East Quay	55
6—10	South Quay	361⅔
11	West Quay	71
12	North-West Quay	31⅔
		789

Area—Land - - - - - - 4.66 Acres.
,, Water - - - - - - 4.61 Acres.
Total 9.27 Acres.
Width of Entrance—52-ft.

IV.—QUEEN'S DOCK.

Berths.		Lin. Yds.
1—17	South Quay	864⅓
2—18	North Quay—Mineral Station	983⅓
21—29	Centre Pier—South Side	556
22—32	North Side	630⅓
31	End	65
19	End of South Basin	76⅔
20	End of North Basin	90
—	West Quay	68⅓
		3,334

Area—Land - - - - - - 24.85 Acres.
,, Water - - - - - - 33.75 Acres.
Total 58.60 Acres.
Width of Entrance.—100-ft.

V.—PRINCE'S DOCK.

Berths.		Lin. Yds.
1—4	North Basin—North Quay (A)	560⅓
6—8	North Basin—South Quay (B)	396
5	North Basin—East End	68⅓
10—12	Centre Basin—North Quay (C)	424⅓
14—17	Centre Basin—South Quay (D)	487
13	East End	68⅔
19—22	South Basin—North Quay (E)	509⅓
24—28	South Quay (Mineral)	655
23	East End	68⅓

Discharging Hams at Princes Dock.

9—18	Ends of Centre Piers	166⅔
29—31	West Quay (F) (G) and 130-ton Crane	333⅓
		3,737½

Area—Land - - - - - - - 39.84 Acres.
,, Water - - - - - - - 35.00 Acres.
Total: 74.84 Acres.
Width of Entrance.—156-ft.

VI.—YORKHILL.

Berths.		Lin. Yds.
1	East Basin—South Quay	100
2	East Basin—East Quay	40
3–5	Riverside Quay—East	517⅔
6	West Basin—East Quay	161⅔
7	West Basin—North Quay	65⅓
8	West Basin—West Quay	202
9	Riverside Quay—West	50½
		1,137

Area—Land - - - - - - - 15.46 Acres.
,, Water - - - - - - - 3.79 Acres.
Total: 19.25 Acres.

VII.—ROTHESAY DOCK.

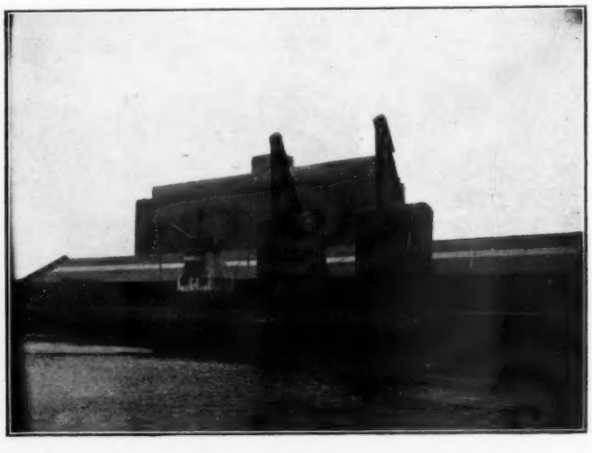
Berths.		Lin. Yds.
1—2	Outer Basin—West Quay	187
3—4	Outer Basin—North Quay	200⅓
5	Outer Basin—East Quay (Hoist)	99
6—8	Inner Basin—North Quay (Hoists)	456⅔
9	Inner Basin—North Quay	157
10	Inner Basin—East Quay	102⅔
11—16	Inner Basin—South Quay	643
17—18	Riverside Quay	199
		2,044⅔

Area—Land - - - - - - - 55.50 Acres.
,, Water - - - - - - - 20.43 Acres.
Total 75.93 Acres.

GRAVING DOCKS.

	No. 1. 1875. Ft. In.	No. 2. 1886. Ft. In.	No. 3. 1898. Ft. In.
Length of floor inside Face and Caisson ...	551.00	575.00	880.00
Length of Floor of Outer Division			460.00
Length of Floor of Inner Division			420.00
Width of Entrance at Bottom	65.00	57.00	83.00
Width of Body of Dock at Floor	55.30	52.40	81.80
Width of Entrance at Top	72.00	67.00	83.00
Width of Body of Dock at Cope Level	94.00	92.00	115.00
Depth of Water on Entrance Sill at Average H.W. Spring Tides	22.10	22.10	26.60

Discharging New Zealand Cheeses at Plantation Quay.



View of Granary, Meadowside Quay, showing Elevation.

GRAIN STORAGE.

The granary adjacent to Meadowside Quay affords storage for 31,000 tons of grain, in 150 silos of 20,000 tons capacity and 11 floors of 11,000 tons capacity.

The grain is discharged from vessels by two electrically-operated travelling bucket elevators and a pneumatic elevator, capable of dealing with an average of 250 tons per hour, and thence conveyed to the granary by band-conveyors. Delivery of grain in sacks or bulk can be made direct to road vehicles or railway wagons, and by band-conveyors to small vessels or lighters.

TIMBER YARDS.

	Open. Acres.	Sheds. Acres.	Total. Acres.
Shieldhall	25.0	1.7	26.7
Merklands	4.5	.1	4.6
Prince's Dock	4.0	1.5	5.5
	33.5	3.3	36.8

(Including 15½ Acres occupied by Railway Sidings.)
Width of Entrance—200 ft.

ABSTRACT.

	Lin. Yds
I.—Riverside (North)	4,499⅔
II.—Riverside (South)	3,686
III.—Kingston Dock	789
IV.—Queen's Dock	3,334
V.—Prince's Dock	3,737⅓
VI.—Yorkhill	1,137
VII.—Rothesay Dock	2,044⅔
	19,227⅔

TOTAL AREA OF HARBOUR AND DOCKS.

	Acres.
Land	211.69
Water	322.77
Total ...	534.46

LAND AVAILABLE FOR HARBOUR EXTENSION.

	Acres.
Shieldhall (including Timber Yards)	150
Shieldmuir	39
Shiels and Braehead	162
Elderslie	233
North Cardonald	109
Total ...	698
(With about two miles of River Frontage.)	—

FLOATING PLANT.

Floating plant of the Clyde Navigation Trust includes the dredgers *Cairndhu*, *Craigiehall*, *Shieldhall*, *Rosslyn* and *Elderslie* two steam digger and two diving bell barges. There are ten hopper barges of 1,200 tons capacity and one of 400 tons capacity. Vehicular ferry boats comprise 3 high-level boats *Finnieston*, *Govan* and *Whiteinch*, and the three chain boats for Erskine and Renfrew. Passenger row-boats comprise 11 steam boats and 4 row boats. There is in addition the tug *Clyde*, the oil separator barge *Plover*, s.y. *Comet*, 140 punts, 77 row boats and 46 buoys.

RIVER LIGHTS: NORTH SIDE.

White Occulting Lights, showing 4 seconds white and 2 seconds dark. Meadowside and Donald's Quay.

Red Occulting Light, showing 4-seconds light and 2-seconds dark. Dalmuir Bowling Wharf, and the lights on the defining buoys from Dunglass to Cardross—Milton, Petty Roy, Sandhead, Helenslee, Horack and Pillar Bank.

White Flashing Light, giving one flash every 4 seconds—Cardross.

SOUTH SIDE.

White Flashing, giving two flashes in quick succession every 10 seconds. Shieldhall, Braehead, Blythswood, Roshielie, Longhaugh, Dumbuck, Garrison, Garmoyle (Buoy No. 13), Turn Buoy No. 7 and Buoy No. 1 at the Boundary.

White Flashing—A 1½-seconds light and 1½-seconds dark. Buoy No. 18 (opposite Donald's Quay), Buoy No. 17 (opposite Bowling), Buoy No. 16 (opposite Dunglass), and the following buoys on the corner Channel, viz., No. 15, No. 11, No. 9, No. 5 and No. 3.

Scandinavian Harbours.*

SÖDERHAMN NAVIGATION.

It is expected that navigation in Söderhamn, Sweden, will remain open until the beginning of 1928. From December 1st the harbour authorities have arranged for an ice-breaker at the loading places in the inner port, such as Källskär, Sandarne, Längrör, Asbacka and Stugsund, and at Wallvick, Ljusne and Nyhamn some weeks later.

SUNDSVALL ICE.

It is expected that navigation will be continued the same as last year until the middle of December at the upper loading places, and at the lower places and to Sundsvall town until about new year.

LULEA HARBOUR.

A covering of ice was reported at Lulea, Sweden, on October 31st, when navigation was already difficult for vessels with weak engines, and was closed for sailing vessels.

KEMI, FINLAND.

A report from Kemi, Finland, on October 31st, stated that there was a covering of ice. Navigation was difficult for vessels with weak engines, and the harbour closed for sailing vessels.

ULEABORG, FINLAND.

A report on October 30th stated that the Uleaborg Roads were partly covered with three inches of ice and that navigation was expected to be closed in the second week of November.

BRAHESTAD, FINLAND.

Navigation was expected to close about November 10th at Brahestad, Finland. It was already difficult on October 29th for sailing vessels.

WASA, FINLAND.

It was arranged that one of the Government ice-breakers would arrive at Wasklot as soon as there was any forming of ice. This will assist all vessels arriving before December 20th.

BJÖRNEBORG ICE.

The large ice-breaker Worina will be stationed on the west coast of Finland during the coming winter. As long as circumstances permit in the Gulf of Bothnia, navigation will be kept open to the port of Mantylnoto. Navigation was possible all through last winter by the aid of this ice-breaker. There is now a broadcasting station at Björneborg, which will be at the disposal of vessels for quick and accurate information.

HANGÖ HARBOUR.

Hangö Harbour, Finland, will be kept open the whole winter. It is expected that navigation will be possible at Skogby, Ekenäs and Skuri until the middle of December.

LOVISA HARBOUR.

It is expected that navigation will be carried on at Lovisa, Finland, until the first part of December, so far as Walkom is concerned. At the outports, Strömfors and Pernovik, the navigation as a rule closes a fortnight earlier.

WYBORG ICE.

There are no signs indicating an earlier closing of navigation in the district of Wyborg, Finland, that usual about the middle of December.

KOTKA ICE-BREAKER.

Cold weather was reported at Kotka Harbour, Finland, at the end of October, but it was anticipated that as soon as the wind turned south or west warm weather would again set in. Navigation is likely to continue until 15th—31st January, and an ice-breaker will be stationed as soon as ice difficulties begin.

ARCHANGEL NAVIGATION.

Thin ice on the Dwina had already made navigation difficult for small passenger boats and transport in wood lighters impossible at the end of October. It was, however, anticipated that the Dwina would be navigable until the middle of November without special ice-breaker assistance. Navigation at Mezen and Petchora is closed. Ice was forming at Leningrad at the end of October.

PERNAU, ESTHONIA.

Navigation is likely to be kept open until the end of the year. As soon as ice appears a Government ice-breaker will be stationed to assist vessels.

* By courtesy of the Baltic and International Maritime Conference.

Shipping Traffic at Hamburg.

Increased Inward Movement in October.

A report received by the Department of Overseas Trade for His Majesty's Consul-General at Hamburg states that there was an increase in the total tonnage entered at the port in October as compared with September, which was mainly accounted for by an increase of nearly 100,000 tons entered with cargo, but there was a decline of upwards of 90,000 tons in the tonnage cleared with cargo.

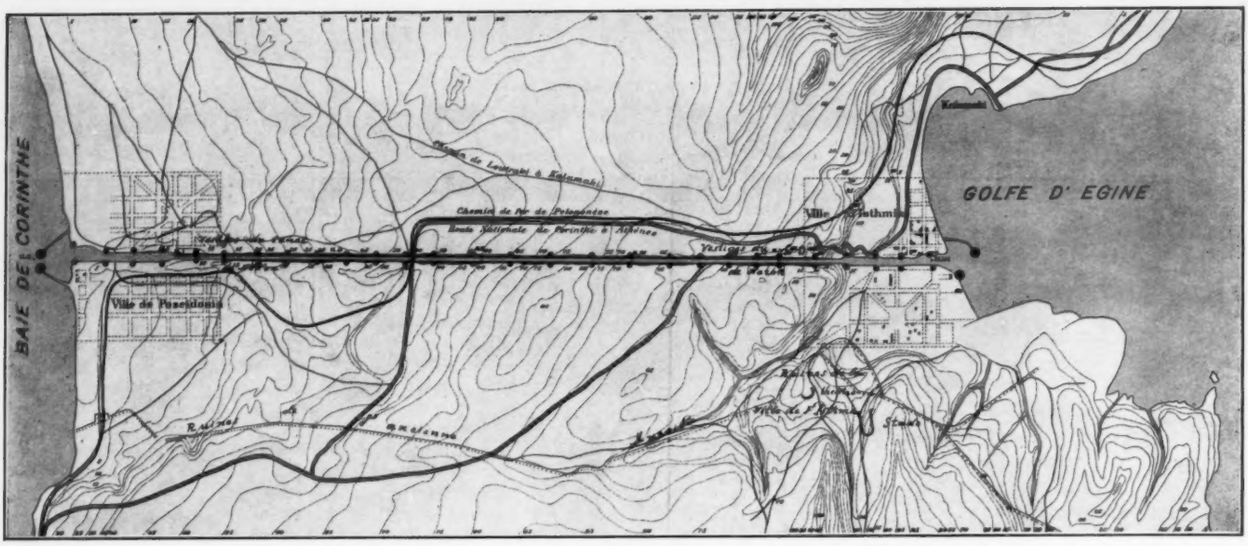
British shipping in October amounted to 244 vessels (468,584 tons) entered, and 221 vessels (401,879 tons) cleared, compared with 200 vessels (375,034 tons) entered and 207 vessels (383,518 tons) cleared in September.

German tonnage in October amounted to 687,788 tons entered (710,018 tons in September), and 709,442 tons cleared (748,491 tons in September).

The Canal of Corinth.

A Famous Waterway of the Near East.

By M. APOSTOLIDES, General Manager, Nouvelle Societe Anonyme du Canal de Corinthe.



Map of the Corinth Canal with vestiges of Nero's Canal indicated at each end.

HISTORICAL.

THE Canal of Corinth connects the Saronic Gulf in the east with the Corinthiac Gulf or the Gulf of Aegina in the west separating the Continental Greece from Peloponnesus in the narrowest part of the Isthmian region, which on the line of the canal is about six kilometres long, reaching an altitude of about 80 metres and still further southward as far as between Kenchreos and New Corinth, an altitude of about 130 metres.

This region was called by the ancients, Isthmus of Corinth, from the town Corinth situated close by and later on at the time of the Byzantins, Hexamilia (six miles) as being six miles long.

In ancient times in order to avoid the long and dangerous journeys round Peloponnesus navigators were compelled to haul their small vessels up to the land and through the " diolkon," a special paved way, constructed by Periandrus, the Tyrannus of Corinth, and pulled them over from the Saronic Gulf to the Corinthiac Gulf and vice versa. Evidences of this " diolkon " are still apparent near the ruins of the ancient walls which separated Peloponnesus from the Continental Greece, these traces are to be seen at present and are more apparent near the western entrance of the Canal.

There had already existed, in ancient times, the idea of cutting through the Isthmus for sea transport facilities. The first who conceived this idea was Periandrus, the Tyrannus of Corinth, one of the seven wise men of Greece, who flourished 600 years B.C. He was, however, unable to accomplish this project in view of the great difficulties. It was further believed that this would have been an offence to Neptune, to whom this place was dedicated.

Three hundred years after, Demetrius the Besieger, wishing apparently to trace a new short route for his fleets, took up the work of the cutting, but had to discontinue it, owing to the pronouncement of his engineers, who held that on account of the unequal height of the waters of the Corinthiac Gulf and the Saronic Gulf, the cutting of the Isthmus would cause Aegina and other islands and islets in the proximity to be submerged.

After Demetrius the Besieger, Julius Cæsar, in the year 44 B.C., with a view to re-populating and rejuvenating Corinth which was laid waste by Mommius, studied the cutting, without however making any effort to bring it to execution.

After the death of Cæsar, the Roman Emperor Caligulas started in 37 B.C. with the work of cutting which was abandoned before the completion of the year, Caligulas having been killed.

A century later, in 67 A.D., the Roman Emperor Nero having been in Greece and having attended the great Isthmian games, set his mind on getting the great work through. The works conducted by the engineers of Nero were started with great vigour in the narrowest place near the Corinthiac Gulf just on the point where the modern canal was opened. The traces of these works are ditches 40 metres wide, the one in the west commencing from the Corinthiac Gulf was 2 kilometres long and the other in the east from the Saronic Gulf was one-and-a-half kilometres long. Apart from this 26 shafts of various dimensions, several ditches and big heaps of excavated earth bear witness to the extent of activity with which the work had been progressing in the short space of 60 days.

Unfortunately on account of the return of Nero, owing to disquieting news from Rome and of his death a little later on, the work definitely stopped.

Since then no attempt was made, for whole centuries, to forward the cutting of the Isthmus.

It is said that the Venetians in 1687 A.D. made such an attempt in the interest of the great trade they were carrying on in the Eastern Seas, but they had had to drop the difficult task.

In the Nineteenth Century there had been repeated revivals of the project of the cutting, notably in the beginning of the Independence of Greece. The Governor of Greece, Capodistria, studied the execution of the work without however making an attempt to execute any operations on account of the high

Sailing Boats being Towed through the Canal.

A Lloyd Steamer coming out of the Canal at Isthmia.

Birdseye View of the Canal, Isthmia.

Maintenance Work in Progress.

expenditure involved, estimated at frs. 40,000,000, a tremendous sum for those days.

At length an International Company under General Tyrr obtained in 1881 the authority from the Greek Government to cut the Isthmus through and it started operations. Under an Act passed by the Greek Parliament the Canal was to be 42 metres wide and not less than 6½ metres deep, in all cases its depth would not be inferior to that of the Canal of Suez. However, General Tyrr, apparently, encountered insurmountable difficulties in his efforts to raise funds for the execution of the work to the aforesaid dimensions, which according to the opinion of the specialists would have entailed great expenditure, in view of which he requested a reduction of the width of the Canal. The Greek Government, before the danger of a long postponement or a definite failure, acceded to his petition to fix the width at 22 metres, but on condition that the depth should be increased to 8 metres.

Sufficient funds having been raised, the official commencement of the operations of the Canal was made on the 29th March, 1882. Unfortunately, as is frequently the case with undertakings of this nature, the estimated period of four years for the completion of the work, proved unsufficient, likewise the estimated expenditure of frs. 30,000,000 far below the amount required, in consequence, it has been necessary for the term of the execution to be extended and new capital to be looked for. The difficulty in providing further capital and other financial troubles brought about the suspension of the operations on the 19th July, 1889. This did not last long.

After the winding up of the Company of the Canal, the New Corinth Canal Company, Limited, was constituted under a special Act dated the 26th May, 1890, and it resumed the work which was finished after a great many difficulties.

The official inauguration of the Canal was celebrated the 25th June, 1893, and the Canal was opened for public use on 28th October, 1893. The whole of the work of the cutting had been divided into five sections. The first section was begun from the western entrance of Possidonia and was ended at a point 1,225 metres away eastwards. The excavation of this section was fairly easily carried out by the dredger as the soil was composed partly of sand and partly of clay not particularly hard. But beyond this spot marking the beginning of the second section and as far as its end at 1,900 kilometres the work met with great difficulties because the ground was very hard and there was abundant water spouting out.

The third section from the 1,900 kilometre mark up to 4,700 kilometres was completed in a comparatively short time, the ground being composed of clay which could be easily dug out. But the most difficult and the most expensive was the fourth section from 4,700 kilometres to 5,600 kilometres, comprising hard and compact earth, sandstone and hard pebble stone, involving the constant use of explosives.

The fifth and last section, from 5,600 kilometres up to the eastern entrance was as easily finished as the first one. Great was the difficulty when water bearing strata beneath the level of the sea appeared. The said strata were not only a serious hindrance to the normal progress of the operations, calling for the use of extensive pumping plant, but they caused floods and serious damage, also, to the shops' gear and railway, etc. Notwithstanding these troubles all the difficulties and dangers were being overcome and the work was finally achieved.

The earth excavated reached 11,000,000 cubic metres, the wall building 145,000 cubic metres and the stone coating of the banks exceeded 30,000 sq. metres. In the year 1907, the Hellenic Corinth Canal Company having closed down on account of financial troubles, its rights were assigned to the New Corinth Canal Company, Limited, which with the collaboration of the National Bank of Greece succeeded and has developed the Canal to its present satisfactory position.

DESCRIPTION OF THE CANAL.

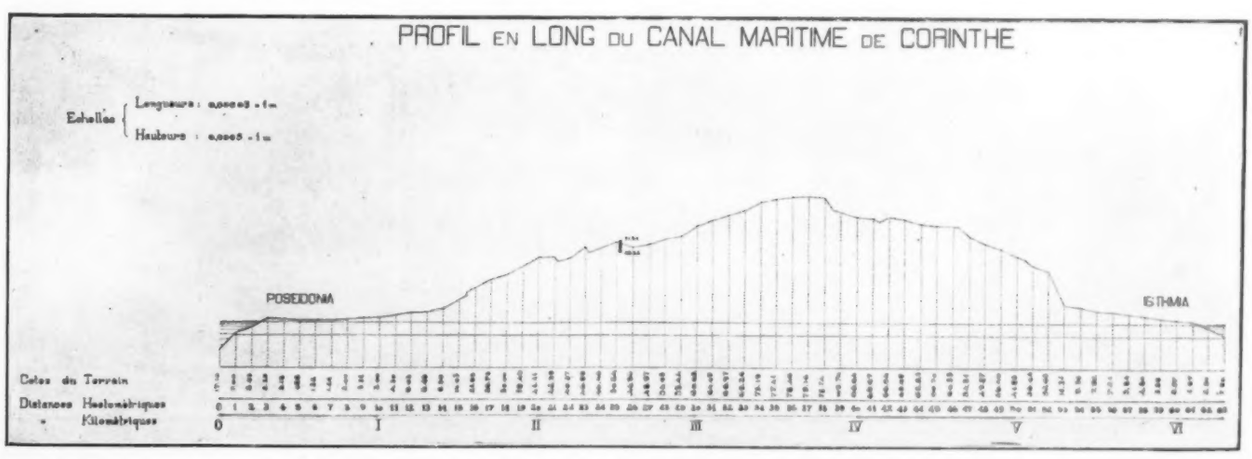
The Canal of Corinth constitutes the shortest way for vessels sailing from the Adriatic Sea and the Northern Mediterranean to the ports of Eastern Greece, Turkey, Asia Minor, Roumania, Bulgaria and Russia and vice versa.

Prior to the cutting of the Isthmus, vessels sailing from the Channel of Messine to Piraeus and going round Peloponnesus had to cover 477 marine miles against 403 they now have to cover through the Canal of Corinth. Vessels from Brindisi to Piraeus had in the past to cover a distance of 464 miles against 333 they have at present to cover when going through the Canal of Corinth. Vessels from Corfu bound for Piraeus and travelling through the Canal save 131 miles and those from Patras to Piraeus 195 miles. Vessels travelling from the Channel of Messine in the direction of the Cape of Sounion and passing through the Canal gain 35 miles and those from Corfu 93 miles.

The Canal having a direction W. 41 ½ N. ploughs through the Isthmus of Corinth in a straight line through uneven ground up to an altitude of 79 metres above sea level. This forms the most important trench in respect of depth and breadth. The total length of the Canal is 6,300 metres, of which wharves of Isthmia and Possidonia occupy 540 metres.

Over a length of 3,500 metres it is provided with stone-coated quays having an inclination of 22½ cm. A space of 1,850 metres is without quayage on account of the unevenness of the natural ground. On the stone-faced sections the bottom of the Canal is 21 metres wide and the surface of the sea 24.60 metres. On the other portion, which is not provided with quayage, the bottom is 22 metres wide and the surface of the sea is between 50 and 70 metres.

An iron bridge 80 metres open and 44 metres above sea level was constructed for traffic facilities between the Continental Greece and Peloponnesus, allowing ships to pass under it with their masts.



Profile Section through the Length of the Corinth Canal.

A View of the Eastern Entrance.

Boat sailing through by help of Wind and Tide.

PASSAGE OF THE CANAL.

Ships of any nationality are at liberty to pass through the Canal both during day and night against payment of the fixed tolls. Small vessels of a tonnage below 800 are not bound to take on a pilot or be tugged, whereas for the vessels above 800 tons tonnage, piloting and tugging are obligatory for the safety of the vessels themselves and the Canal. The passage of the Canal is subject to special canal sailing rules.

Prevailing winds are north-west blowing just to the axis of the Canal and next come the east winds. North winds are rather scarce and command more attention on the part of vessels entering Possidonia (Corinthiac Gulf). In the case of a very strong north wind, vessels intending to pass from the Corinthiac Gulf may call at the near safe bays of Livadostro, Ghermanou and Vathi or anchor east of the Cape Malaggavi near Loutraski, to await for news by wireless from the Canal Service as regards the proper moment for the passage.

East winds, however strong they may be, do not incommode vessels passing through the Canal from the eastern entrance.

The currents of the Canal alternate with each other twice a day at hours relating to the tides, they depend nevertheless on the winds whose directions they follow whenever these winds are continuously blowing in the same direction for two or three days. However, the speed of the current never exceeds 3 miles per hour and it is usually confined within the limits of 2½ miles.

The change of current is gradually accomplished, the velocity being reduced until the waters come to a standstill, then after a certain duration of stillness the current resumes its course, but in an opposite direction and so on. Rise and fall of waters fluctuate within limits not in excess of half a metre. They follow the direction of the current and are subject to the influence of the winds.

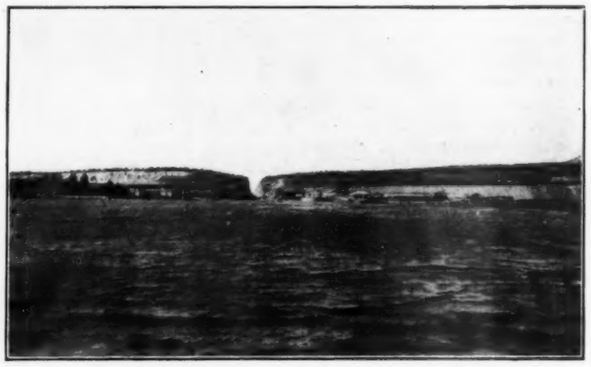
The Canal is illuminated during the night by 32 candle-power electric glow lamps placed in pairs opposite each other in a perpendicular direction in respect of the axis of the Canal and are at intervals of 200 metres.

The entrance of the Canal is likewise lit up with electric port lamps of 32 candle-power, visible on all parts of the horizon from a distance of 6 miles with a green light to the right and red to the left-hand of the vessel entering the Canal.

Vessels sailing by night towards the Canal are well guided, as regards the Corinthiac Gulf by the intermittent white light of Malaggadio's lamp with a range of 20 miles and as regards the Saronic Gulf by the steady light of Sousakio of 18 miles range. Moreover, a system of lamps of sufficient tension and properly placed constitutes a guarantee for the vessels sailing by night either from the Corinthiac Gulf or from the Saronic Gulf.

TRAFFIC IN THE CANAL.

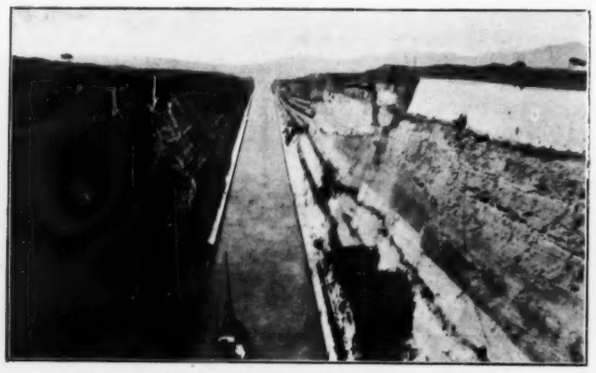
In the beginning the traffic of the Canal and the results obtained from its operation were not up to the expectation. Even the ships of the Hellenic Steamship Company hesitated to pass through the Canal and the Great European Steamship Companies especially the Italian and the Lloyds companies after certain superficial observations and negotiations definitely refrained from making use of the Canal. As a result, during the year 1894, only 2,085 vessels of a net tonnage of 240,000 passed through it. Down to 1905 the yearly average number of the vessels passing through the Canal did not exceed 2,600 of a net tonnage of 260,000. From 1906 up to 1912 this number slightly increased. It was only in 1912 and during the great war that ships of great displacement, afraid of the torpedoes, attempted to pass the Canal. The steamship companies having since realised that there is not in reality any risk for their ships, are now continuously making use of the Canal considerably to their own profit, and that of trade in general.



Eastern Entrance, showing Manager's and General Offices, Isthmia.

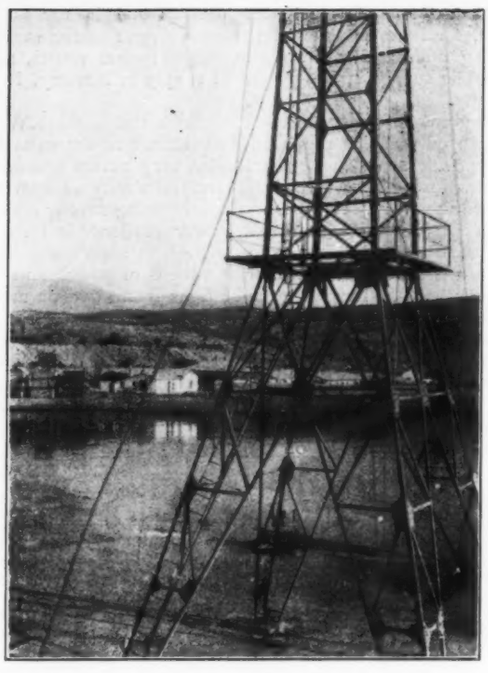
Whilst in the 19 years from 1893 to 1912 the total number of 1,000 tonnage vessels which passed the Canal of Corinth amounted to 754, 84 of 1,000 tons or over passed through in 1912 and in 1918, 754 vessels of that tonnage, including the English ship *Dortcleap* of a net tonnage of 5,311. During the year 1926, 8,050 vessels of net tonnage of about 3,000,000 passed through the Canal. Out of these 430 vessels were of a tonnage above 1,000 and 405 of a net tonnage above 2,000, amongst which were 47 of a net tonnage of 3,000, including *Themistoclis* of the Hellenic National Steamship Company, the *Stella d'Italia* of the Italian Company, the former of net tonnage of 3,925 and latter of 3,325, and others.

It cannot therefore be ignored that it was impossible for the Company of the Canal of Corinth, in the early years, to provide for the working outlay and at the same time for the means of improvement of the Canal and especially to take serious steps



Birdseye View of the Western Entrance, Possidonia.

The S.S. "Andros" entering the Canal at Isthmia.



Eastern Side of Canal. Wireless Mast in foreground.

towards protecting it from the dangers of falls which in a few places on account of the bad composition of the ground and the influence of the sea and rain, occurred from time to time.

Already now, by reason of the steadily improving financial condition of the undertaking, the Company has commenced important operations designed to relieve and solidify the banks of the Canal. Its Board of Directors are making arrangements for the supply of the necessary machinery and material in order that after completion of these operations on a larger scale and in a more methodical way, any danger of fall in the future, will be altogether eliminated.

MACHINERY APPARATUS AND STOCK OF MATERIAL.

The Company of the Canal of Corinth owns and maintains in Isthmia for traffic purposes in the Canal:

(1) The necessary tow-boats and in general boats and machinery tools required for temporary repairs to its floating equipment and incidentally of any vessel passing by, which needs temporary repairs.

(2) Power house for the production of electric light. The electric energy is generated in a central station located in the eastern entrance of the Canal. It is from the station mentioned that the service lines start to feed on the one hand, the lamps of the Canal and those of the Settlement of Possidonia and on the other hand, the lamps of the offices of the streets as well as those of the Settlement of Isthmia. The supply of energy is effected in the form of continuous current of 220 volts. tension on an average. The total installed power of the station is of 70 H., and comprises three petrol-driven engines, Semi-Diesel and Diesel.

(3) A wireless telegraphy post of $\frac{1}{4}$ kw. power of 60-80 marine miles range, with a wave-length of 600, which can however be raised to 300, fitted with Marconi type spark transmitter and corresponding receiver 31 A, with co-efficient Marconi 71. Inverted L-shaped Antenn. The calling signal letters of the wireless telegraph of the Canal are S.W.L.

(4) At Isthmia (eastern entrance of the Canal) are located the offices of the Service d'Exploitation, the shops, dockyards and the store department of the Canal, coal shed, benzine, mineral oil, timber, sundry tools and articles necessary for the operation,

View of Canal from a Tug.

working, repairs and maintenance of the floating stock of the Canal and its various installations and machinery.

The Corinth Canal Company can supply such vessels passing through the Canal as might eventually have fallen short of their stock and for their way up to Piraeus (a distance of about 32 miles), where there are large stocks available of every kind of material, with articles of various sorts in small quantities such as benzine, mineral oil, rough petroleum, etc.

Vessels travelling through the Canal may complete their water supply with spring water from the aqueduct at Isthmia, lying close by the quay in the beginning of the outer port of Isthmia by means of a special water-feeder.

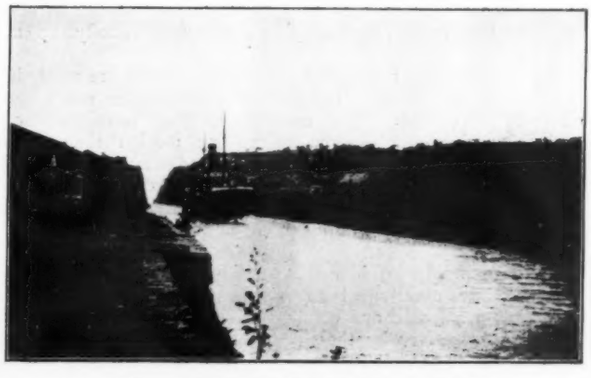
ANTIQUARIAN RUINS.

Travellers on their journey through the Canal, alighting at Isthmia, may visit attractive and interesting ruins and monuments of ancient times.

In a quarter-of-an-hour's walk there are the relics of the Temple of Neptune, who was worshipped at Isthmia and to whom was dedicated the Isthmus. In the ancient times it was a majestic and a rich temple within a great Temenos which comprised other sacred places, temples, statues, etc. Near the Temple are to be seen the ruins of the theatres and in the east the foundations of the walls of the Stadium where the famous Isthmian games were held in Summer and which after the Olympian games were the most sumptuous festivities of the ancient Greeks.

The yard of the Stadium coincides in the north and north-east with the great walls which were extending throughout the whole of the width of the Canal and which guarded Peloponnesus and the Continental Greece.

Five kilometres on the east of Isthmia was situated the eastern port of Corinth, Kenchreae, the relics of which covered by the sea, are still to be seen.



Steamer entering the Canal at Isthmia.

The "Milano," Servizzio Maritimo, being Tugged.

Harbour Engineering Notes.

ELECTRIC ARC WELDING.

Considerable developments have recently taken place in the application of electric welding, particularly in this country, and a noticeable feature of the recent Shipbuilding and Engineering Exhibition was the high standard achieved by the designers of welding sets, and the interest shown in them by visitors. Much work has been done in this country in the application of electric welding to heavy steel structures and plant, though gas welding is still very popular in America. Recently, however, the electric process has been used in the latter country in the erection of steel frame buildings in place of riveting.

There is little doubt that, compared with riveting, the electric welding process results in considerable saving, and even the most conservative designers are being converted to this fact. Where riveted construction is employed, the plate must be layed off from the templates and every rivet hole marked and centre punched before the plate reaches the machine shop. In the shop the holes are punched or drilled, the plate sheared, and then sent out for assembly in the finished structure. After the plate has been bolted in position, it is frequently found necessary to ream many of the holes before they can be filled with rivets. After driving, the rivets must be tested, and every rivet head and every inch of seam caulked to ensure watertightness.

By eliminating the routine of marking off, punching, reaming and caulking, to say nothing of the butt straps and insertions at watertight joints, there is ample margin to cover similar construction by means of electric welding until the process has become standardised, when costs will be still further reduced. With the welding method the plate is sheared to size, the edge being automatically bevelled by the rotary shear at the same time. A few holes for erecting bolts may be necessary, but otherwise the work is free from holes when delivered to the welder.

It is estimated that on the minor parts of a ship, welding involves a saving of at least 60 per cent. over riveting, and on the hull plating 25 per cent. Tests have shown that a riveted joint possesses 60 to 85 per cent. the strength of the original steel, and that welded joints have 80 to 100 per cent. strength.

The normal temperature of the metallic arc is approximately 3,300 deg. Cent., while that of the acetylene flame is approximately 2,500 deg. Cent. The minimum heat of the metallic arc has a high value, but the heat of the acetylene flame can be regulated down to a very small value. It follows, therefore, that for thin sheet metal work (less than $\frac{1}{8}$ in. thick), and for small cast iron work, the acetylene flame is cheaper and easier to apply than the electric arc. With acetylene welding, however, crystallisation, hardness and tensile strength of the welded metal depend on the purity and the proportion of the bases used, a fact which is often a source of trouble.

Welded sheet metal is lately rapidly superseding iron castings for such plant as tanks and boxes, where the metal is of thin cross section. A sheet metal tank is frequently made more quickly and cheaply than a cast iron tank, is lighter in weight, and practically unbreakable.

ELECTRICITY GENERATION BY DIESELS.

An interesting feature of the growing use of electricity for industrial and domestic purposes in Europe is the increasing number of Diesel engines which are being installed for generating this electricity. In consequence of their technical advantages, these engines are being found particularly suitable for use in central and private stations, either as independent machines generating the whole energy, or as a standby operating in conjunction with other sources of supply. The Diesel engine is becoming more and more indispensable as an auxiliary in large power stations. It can take the peak loads at a time when the demand on the station is greatest, operating, therefore, only a few hours at a time. It is, however, also capable of operating at full load and thus assisting to maintain the supply when a breakdown has occurred in other parts of the plant or when the demand for power continues to exceed the capacity of the main plant.

With regard to the size of the engines, it is possible to build them to comply with all requirements within wide limits. Certainly, they have not attained the huge outputs given by the largest modern steam turbines, but it is possible to construct single-acting Sulzer two-cycle Diesel engines in units developing up to 8000 B.H.P. each. There are, however, many plants requiring only medium sized engines, so that Diesel is consequently often adopted as a standby in hydro-electric and steam power plants.

Long experience in Europe has shown that the 1,000 KW unit is a size for which there are numerous opportunities for employment, and this is proved by the large number of units of this output which have been installed in central and private generating plants in Europe. In all, about 50 or so, 1,000 KW Sulzer Diesel plants are in regular operation in Europe for various purposes, for instance, lighting and tramways, public supply, steel works and radio transmitting stations in France; spinning mills and tramways in Russia; steel works, subways and public supply in Spain; public supply in Norway, Italy and Germany.

The great diversity of uses in which the 1,000 KW Diesel is employed must be regarded as evidence of the suitability of this type for supplying power under very severe conditions as regards closeness of governing and reliability of service.

There are many reasons for the increasing favour shown this size of Diesel. Medium-sized power stations find the 1,000 KW standby plant a unit large enough to supply any shortage due to a breakdown in the other sources of power and to take the peak loads. Large power stations instal two or more sets of this size, thereby enabling the total output to be graded so that the sets in service are operating approximately at full load and therefore at their highest efficiency. The dimensions of the set are such that it can always be kept under observation when running and can be easily attended by one man.

For lesser outputs, say up to about 300 B.H.P., an airless injection Diesel engine of very simple construction is proving very popular. In this engine, by combining the two-cycle process with a patented method of atomising the fuel without the aid of compressed air, a new type has been evolved which works on the Diesel principle and can hardly be excelled for simplicity of construction. The adoption of the two-cycle principle means the elimination of exhaust and air inlet valves with the valve gear.

Ignition in these engines takes place on the Diesel principle; that is to say, before fuel is admitted, the air in the cylinder is compressed to about 425-500 lb. per sq. in. and consequently attains a temperature at which the fuel ignites immediately on being injected. Fuel injection takes place gradually, the amount being automatically regulated at the fuel pump by the governor, corresponding to the load on the engine.

The fuel is injected under pressure through an automatic valve into a subsidiary chamber, the ignition chamber, which is in communication with the working cylinder and consequently filled with compressed air at a high temperature. A small portion of the fuel at once ignites, thus causing a certain rise of pressure and temperature. Owing to this pressure, the fuel subsequently injected into the ignition chamber is driven in a finely atomised state into the working cylinder, where combustion continues exactly as in a Diesel engine of the usual type, that is to say, without any sensible rise of pressure.

Two Diesel engines, each of 2000 B.H.P., have been installed at the central generating station, Berne, Switzerland. These engines have been used to take the peak loads, and such engines are typical of many being adopted throughout Europe.

GEAR GRINDING AND CUTTING MACHINES.

The problem of pinion grinding has been the subject of considerable investigation, the chief difficulty being the unavoidable wear on the grinding wheels, which causes a continuous deformation of the tooth profile. Various efforts have been made to offset the deformation by trueing up the grinding wheels from time to time, though it is often found that the deformation taking place between trueing up operations is sufficient seriously to affect the precision of the work.

These troubles have been overcome by a grinder designed on a new principle, which is being used on an increasing scale in this country for all classes of work. This grinder utilises the Maag principle, in which the grinding wheels are made in the form of slightly tapered saucer discs and cut with their inner edges only. Thus, the straight flanks of the generating rack tooth are represented by the projection of these inner edges, which naturally always lie in a plane, even when the edges wear out. This wear of the wheel, however, does not influence the shape of the generating flank at all, but only means a shifting of the working plane in the direction of the axis of the grinding wheel. The shifting of the grinding edge, which would cause the teeth ground later to be thicker than those ground previously, is automatically overcome by a special device which operates as soon as the slightest wear of the grinding edge has taken place, thus keeping it always in exactly the same position.

Where machines employing the Maag system are used, it is found that the smallest number of teeth can be cut without under-cut, and that the contact motion provides for a considerably greater degree of rolling motion than sliding motion, thus prolonging the life of the gear to a very appreciable extent. Entire freedom in regard to centre distances is allowable for each individual case as the Maag method makes it possible to cut any desired pitch without the need of special tools.

In the grinding machine the position of each cutting edge is automatically maintained to within 0.00004 in. by a feeler operating a solenoid and compensating screw. The two grinding discs are driven by their own motors, and are mounted on separate tables carried on a common slide so that the two cutting edges may be set to represent the tooth of a cutter of any pitch.

The gear to be ground is fixed on a horizontal slide and receives a reciprocating motion from a crank disc at the side of the machine, while the necessary rolling motion is provided by a pitch block and steel bands. Involute gears of any pitch circle within the capacity of the machine may be ground, nine pitch blocks only being required.

In addition to the involute generating motion, the work is also fed beneath the two grinding discs so that the teeth of gears of any face width may be ground. Dividing may be set to take place at either or both ends of the gear immediately the grinding discs are clear of the work, after which the table feed motion is reversed, both operations being automatic and controlled by adjustable stops. To secure accurate spacing of the gear teeth, the dividing plates have taper slots which are hardened and ground so that the error from any one tooth to an adjacent tooth does not exceed 0.0001 in. A gear box at the front of the machine provides four speeds for the reciprocating motion and four speeds for the feed.

In the cutting machine involute teeth of any standard or corrected tooth form may be produced, the machine working on the generating principle, using a rack type cutter. The cutter machine is of the vertical type, the work being supported on a horizontal table, and a pinion driving through two sets of change wheels on to the lead screw, worm and worm wheel, provides the required generating motion. The cutter slide is actuated by a crank pin and link and is balanced by a counterweight.

Nine cutting speeds are provided through hardened and ground gears enclosed in the body of the machine, and the feed is adjusted by varying the stroke of a pivoted lever. In addition to the lead screw, there is also a second quick-threaded screw driven by friction from a small gear mounted on the lead screw, the object of this being to keep the table nut locked between these two screws, thus automatically taking up backlash between the table nut and lead screw.

Means are provided for setting the cutter dead parallel to the work table slide. When generating teeth, the gear blanks may be rolled into the cutter from either end, thus allowing all teeth in the cutter to be used before resharpening becomes necessary. All motions during the quick reversing period are controlled by an automatic drum at the back of the machine.

Gears cut on the Maag system are at present in use on motor cars, motor lorries, machine tools, turbine reduction gears, electric locomotives and tramcars.

THE HELIX CLASSIFIER.

Introduced first to effect the separation of sand from slime in the cyanidation process, the helix classifier has, during the past few years, been adapted to a wide variety of chemical processes. This classifier consists of a trough enclosing a revolving helix. The trough is inclined at one end, where the slime is discharged, while at the upper end is a hopper for the sand. Revolving on a central axis in the trough is a spiral blade, which is single and continuous at the overflow end for part of the length, and double with interrupted flights for the rest of the trough. The spiral is gear-driven and revolves at from three to five revolutions per minute.

In operation, the pulp entering the feed box meets the slowly moving spiral, the heavier solids settle to the bottom of the trough and are gently advanced out of the surface of the bath toward the sand discharge end, the intermittent spiral permitting the contained moisture to flow back into the charge, the slow turning over of this sand washing the finest solids back and allowing the sand to dry with the exception of that moisture held by capillary attraction. The lighter solids suspended in the liquid flow over a weir into a collecting hopper.

A classifier of this type will give a close separation at 60, 80 or 100 mesh, but where a much finer slime has to be dealt with, a modification of this classifier, giving greater volume in the bath and increased length of the overflow weir, has proved very satisfactory.

AUTOMATIC SUB-STATIONS.

The increasing use of electricity in this country, whether from central generating or hydro-electric power stations, will inevitably involve a more widespread use of automatic sub-stations, and it is gratifying to note that British manufacturers of electrical equipment probably lead the world in the design and construction of plant for automatic sub-station operation. Automatic control gear is now being constructed in this country which not only performs all the operations of switching, starting up and shutting down electrical generators and converters—operations usually performed by skilled attendants in manually operated stations—but perform these operations more efficiently and with even greater reliability than prevails with the most carefully supervised manual equipment, in addition to which the automatic control gear provides full protection to the machinery and the load at all times. Every contingency is provided for and nothing is left to guesswork or to the judgment of an operator.

Up to the present time no operating condition has yet arisen which cannot be satisfactorily dealt with by automatic control gear. The machines in an automatic sub-station may be started up and put into service by any one of several methods, according to requirements. For instance, the machinery may be started up (1) when the load demand reaches a predetermined value, (2) by a manually-operated master control switch, situated in some distant control room, (3) by a time switch, (4) by closing a high tension feeder switch at the power station or at some other point, and (5) in the case of a hydro-electric station, by a float switch. When the machinery is started up automatically arrangements may be made so that an audible signal is given at a distant point so that the engineer in charge may know that the station has started up, and is operating satisfactorily. In other cases various audible alarms can be incorporated in the design of the station. In one coal mine, for instance, the automatic sub-station is started up by means of an automatic telephone installation, the controller dialling a certain number and the station corresponding to that number starts up. An audible signal is given by the station which is transmitted to the earpiece of the telephone receiver, so that the controller is advised that all is well.

There are a large number of technical advantages which commend the automatic station to electrical engineers, such as economical buildings, noiseless construction, economy in distribution, more economical running of machinery when the station is controlled by load demand, more uniform line pressure, complete protection against all abnormal conditions and the possibility of regeneration in the case of traction schemes in districts with long gradients. Automatic sub-stations have been successfully applied to traction, municipal power and lighting, mining, industrial power and lighting, hydro-electric supply, railway signal service, and battery charging.

PROTECTIVE THERMAL OVER-CURRENT RELAYS.

A new form of thermal relay has been developed as a protection for motors with the object of enabling the user to get the maximum continuous service from the machine without danger of injuring the insulation through over-heating. The usual forms of protection, viz., fuses and electro-magnetic relays, while affording protection against excessive overloads, cannot protect against prolonged overloads just above the normal rating of the motor. In other words, the thermal relay protects by temperature and not by pre-determined excess of current. It allows a motor to carry an overload to the limit of its heating capacity without unnecessary tripping.

A relay having such a characteristic is especially suitable for motors subjected to a variable load, such as on machine tool work. Brief overloads of 40 to 50 per cent. will not injure the motor if followed by a sufficient period of under-load or light running. It is practically impossible to pre-determine either the amount of overload or its duration, or the period of rest in such cases, so that time-lags and similar devices, in conjunction with electro-magnetic equipment, do not give the ideal protection. With the latter in use the motor may frequently be unnecessarily stopped on heavy overloads of short duration when the temperature of the machine is such that it could safely withstand such temporary loads.

Thermal over-current relays are also particularly adapted to those conditions where a high peak current is momentarily experienced when starting up, e.g., when switching a squirrel cage motor direct on to the line, or at starting and when switching over to " running " with two-position starters.

The device consists of a heating element, heated by the current in the motor circuit, a latch composed of B.T.H. thermostatic metal, which curves upwards when heated, contacts which may be connected in an under-voltage or contactor coil circuit, which open the circuit when released by the thermostatic strip, and mechanical means for re-setting the latch after operation on overload.

The thermostatic metal is a duplex metal prepared by the permanent union, or welding throughout their length, of two metals having widely different co-efficients of expansion. The varying rates of expansion or contraction of the two metals cause the whole strip to bend when heated. This reaction is always the same in a given strip, for a given temperature change, and therefore functions reliably. No current is carried by the strip.

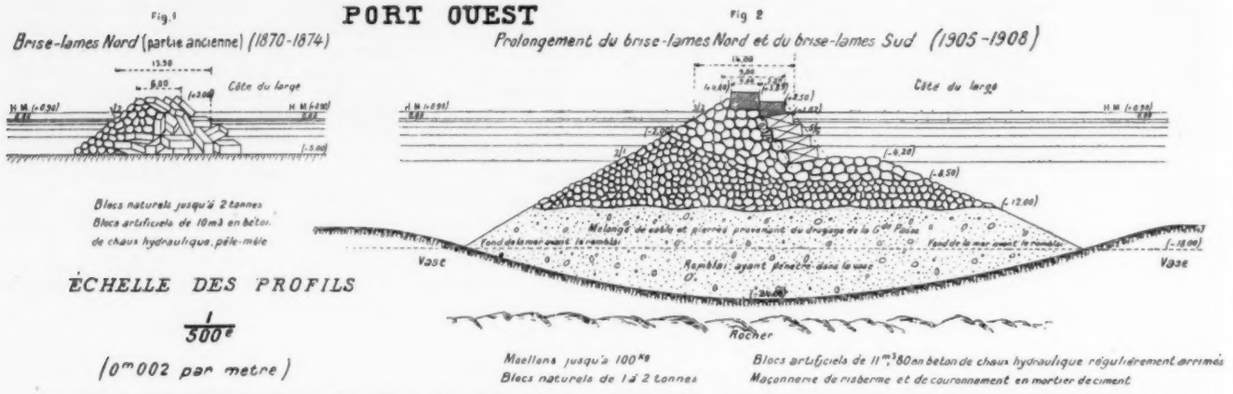
The device is intended primarily to protect the motor against ordinary working overloads, but not against severe electrical faults, such as short circuits. They will handle, satisfactorily, loads up to approximately ten times the full load current at which the relay is rated. There should, therefore, be in the feeder, or branch circuit, an instantaneous trip circuit breaker, set at not over ten times full load current, or fuses rate at not over five times that figure. After operation on overload the relays are usually re-set by hand. In special cases, where remote control is essential, an electro-magnetic re-setting device can be fitted.

NEW JAFFA WAREHOUSE.

A modern warehouse and Customs stores of 1,300 sq. metres floor area provided with electric goods lift and loading platforms is under construction at the Port of Jaffa, Palestine.

The Port of Alexandria.

By ROY S. MACELWEE, Commissioner of Port Development, City of Charleston, S.C. U.S. Delegate to the Fourteenth International Navigation Congress, Cairo, Egypt, 1926.



Cross Sections of Breakwaters, West Port, Alexandria, with acknowledgments to "Special Report," Monsieur M. E. Quellennec, 14th International Navigation Congress, Cairo.

THE Port of Alexandria, Egypt, the third in importance in the Mediterranean after Marseilles and Genoa, is the gateway for 95 to 99 per cent. of the flourishing commerce of Egypt and the Sudan. Its average annual turnover is about £100,000,000, divided in the ratio of about 60 per cent. exports, and 40 per cent. imports.

Alexandria is a thoroughly modern and well equipped commercial sea port where vessels drawing as much as 30 ft. lie alongside the quays to load or discharge.

HYDROGRAPHIC CONSIDERATIONS.

The old lighthouse on the western point of Ras El Tin is situated at 31 deg. 11 mins. 43 secs. north latitude and 29 deg. 51 mins. 40 secs. east longitude. This cylindrical tower, 55 metres (180 ft. 5 in.) in height was erected in 1844. The revolving light is prismatic with 24 faces, with a continuous flash *in toto*. The light is visible for 20 miles.

There are two approach channels: (1) One from the North West to South East called Boghaz Passe, is on the axes of the range lights shown by the Small Tower of Mex and the Great Lighthouse of Mex visible ten miles. The Boghaz has a width of 91.5 metres (300 ft.), depth of 9.15 metres (30 ft.) for a distance of 1,600 metres (1 mile), crossing the shallow water that parallels the coast. Through the channel **90 deg.** turn to port leads through the entrance into the outer harbour between lights at the end of both the jetties; green, right; red, left. Thence an almost straight course marked by light buoys passes through the outer harbour and anchorage into the inner of the commercial harbour.

(2) The main channel entrance, le Grande Passe, crosses the bar from approximately West by North on the range of lights of the Small Lighthouse of Mex (Petit Phare du Mex) and the Great Lighthouse of Mex (Grande Phare du Mex). It has a width of 183 metres (600 ft.); a depth of 10.66 metres (35 ft.) for a distance of 2,000 metres (1¼ mile). The inner end of the channel is marked by a light buoy, thence an easy turn of about 60 deg. to port brings the vessel into the main harbour channel, approximately parallel with the shore.

TRAFFIC.

Alexandria, showing little trace of its ancient history is a modern city of 500,000 population. It is connected with the Nile system by the inadequate Canal Mahmoudieh leading from the inner port, Basin of Commerce, to the West branch of the Nile called Rosette through the town of Fouah, a distance of 90 kilometers (56 miles). This canal has a depth of 2 metres 70 centimetres (8 ft. 10 in.) and a width varying from 25 to 40 metres (82 ft. 130 ft.) Its navigation is slow and difficult and is carried on in typical Nile sailing vessels towed by men in harness, à la Volga Boatman, assisted by the single graceful sails when a wind is favourable. This canal needs improvement to accommodate the press of traffic passing through it.

Railroad connection with Cairo, and with Port Said although round-about, is furnished by the State Railroads of Egypt. There are three stations in Alexandria; the Station of Ramleh for the East, the Cairo Station in the middle and the Galbari Station near the Canal Mahmoudieh to the West. These rail connections are extended on to most of the quays although not to the number and extent usually considered essential in modern port construction.

TAXES AND DUES.

The present tariff set by Treaty requires the Egyptian Government until 1930 to levy no duty on products of the soil or of industry in excess of 8 per cent. ad valorem, except upon alcoholic beverages not exceeding 50 per cent. of alcohol, which is taxed 10 per cent. ad valorem and 15 per cent. above 50 per cent. of alcohol. There is an export tax of one per cent. ad valorem on all exports of Egypt and an additional export quay dues of 12 per cent. on general mechandise.

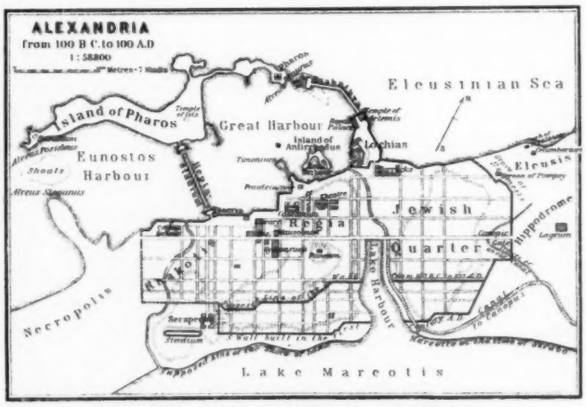
Importations and exportations are facilitated by two warehouse companies, the Bonded Store Company, Limited, with a reinforced concrete warehouse of 20,000 square metres (215,280 sq. ft.) and the Egyptian Bonded Warehouse Company, Limited, that also acts as agents, as custom house brokers, as forwarders, and issue warehouse certificates and warrants on goods stored in their warehouse.

The principal agents of the steamship lines and firms have their offices in Alexandria not only because of the concentration of the business of Egypt at this point, but also due to the fact that the seashore to the East of the City proper is a summer resort of Egypt where the wealthy merchants, cotton brokers, and pachas have their villas. One very large and extremely attractive hotel in particular, the Casino San Stefano, is the rendezvous of smart Egypt in summer as it is of the smart Europeans in the winter.

THE PORT OF ALEXANDRIA.

Alexandria is situated on a peninsula extending at right angles from a long low shore line separated from the mainland by Lake Maryut, a typical North African lagoon salt lake, of a depth of approximately 2 metres (6 ft. 7 in.) The peninsular Ras El Tin branches to the East to Fort Kait Bey and to the West to Point Ras El Tin. This Western branch afforded a natural shelter together with the continuation of the branch in the form of a bar or ridge extending to the Island Abbou Baka and other points for a distance of ten kilometres (6.2 miles). This isthmus is approximately 700 metres (2,297 ft.) wide and 3 kilometres (1.9 miles) long.

The same Pharos Island as it was formerly, it having filled in since, was mentioned by Homer in the Fourth Book of the



Alexandria, between 100 B.C. and 100 A.D.
[*Baedecker's "Egypt."*

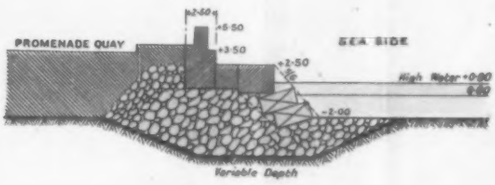
PORT OF ALEXANDRIA.

UNDER THE JURISDICTION OF THE ADMINISTRATION OF PORTS & LIGHTHOUSES.

DIRECTOR-GENERAL;- EL-LEWA PHILIP STREATFIELD PACHA, R.N..

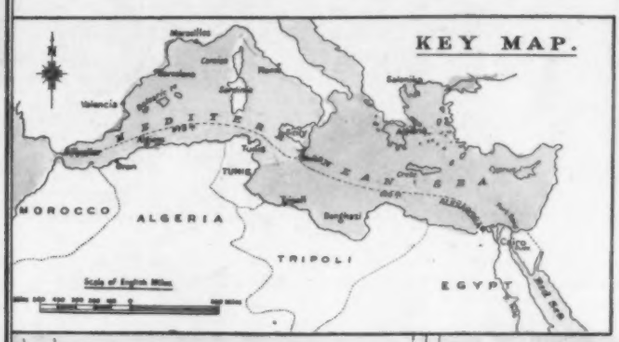
SECTIONS OF E

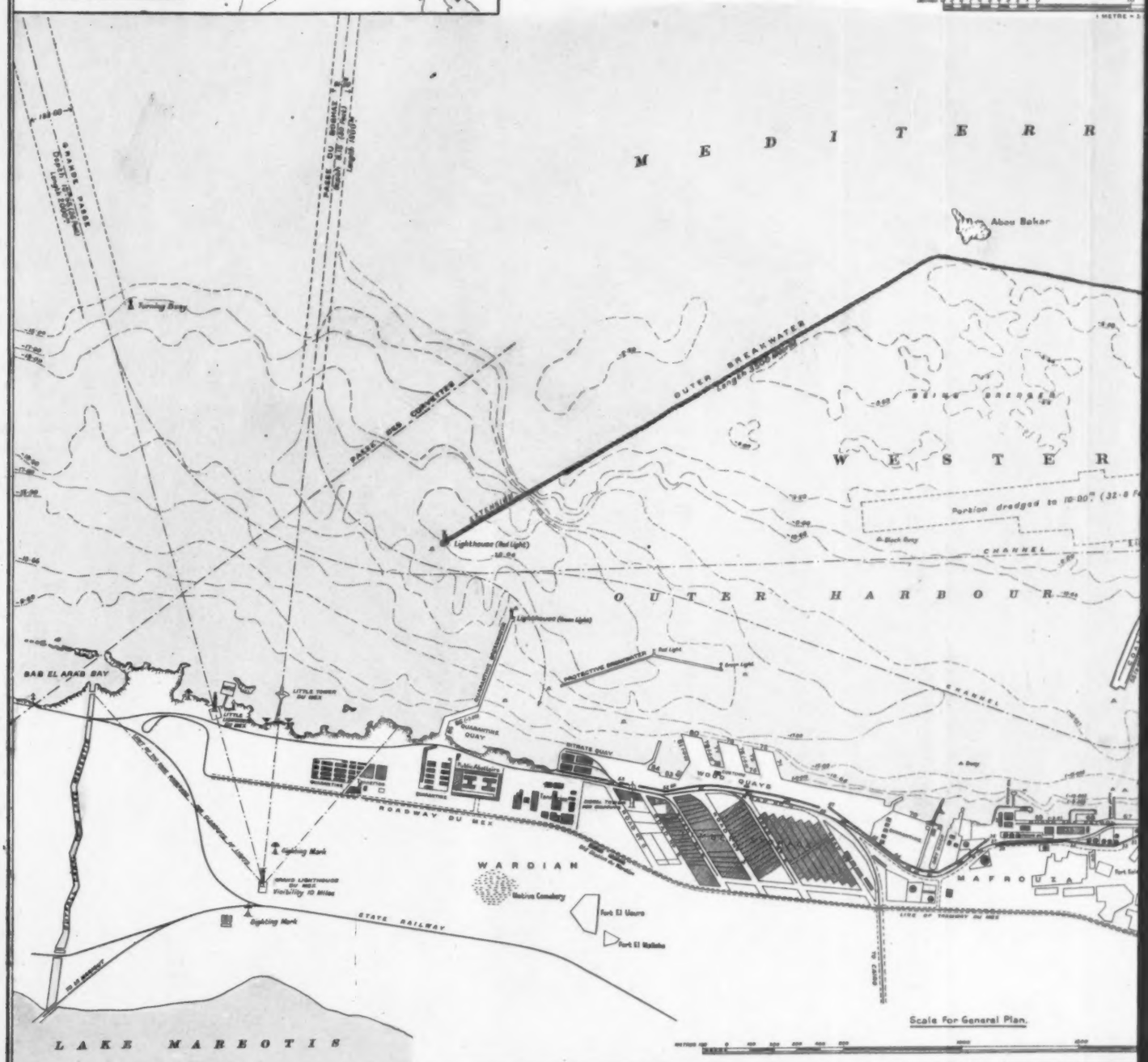
PROMENADE QUAY (1905-1908)



Ashlar and Rubble
Natural Blocks 100 to 1000 Kgs
Natural Blocks 1000 to 2000 Kgs
Artificial Blocks of 10 Cubic Metres-evenly trimmed.
Masonry in Hydraulic Lime Mortar.

Scale for Sections





WARD & FOXLOW. Harcourt St., Ma

T TO THE DOCK AND HARBOUR AUTHORIT

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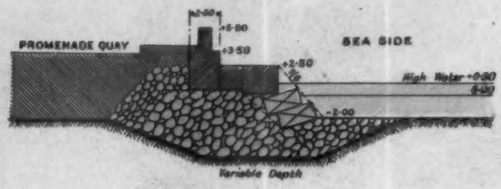
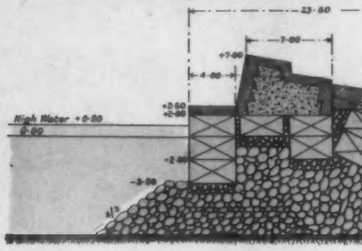
SECTIONS OF EASTERN PORT.

PROMENADE QUAY (1905–1908)



Ashlar and Rubble
Natural Blocks 100 to 1000 Kg.
Natural Blocks 1000 to 2000 Kg.
Artificial Blocks of 10 Cubic Metres – evenly trimmed.
Masonry in Hydraulic Lime Mortar.

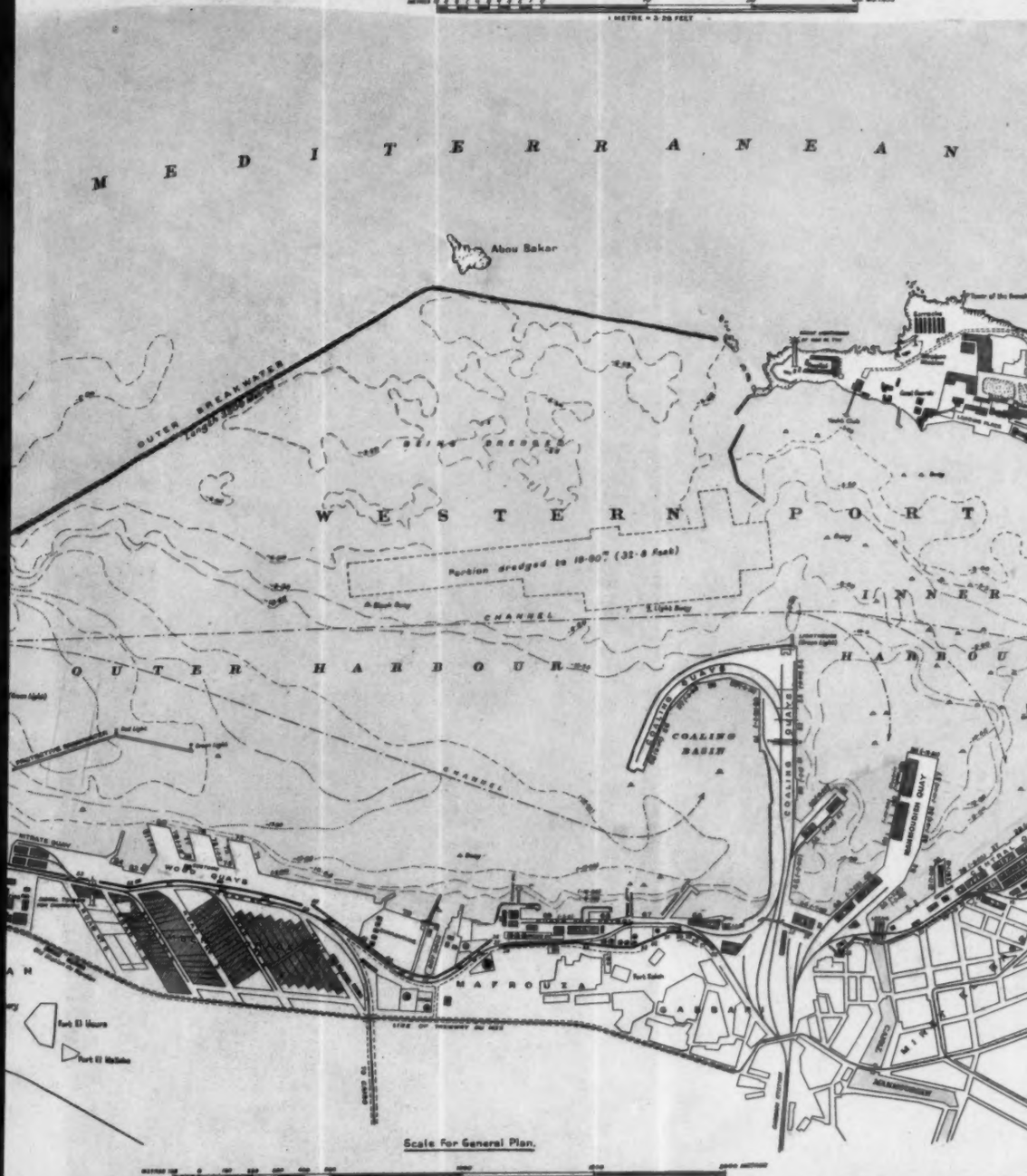
BREAKWATERS (



Natural Blocks of 1 Ton.
Natural Blocks of 1 to 5 To
Artificial Blocks of 22·4 cub.m
Hydraulic Lime Mortar – half
Capping of Concrete & Cemen

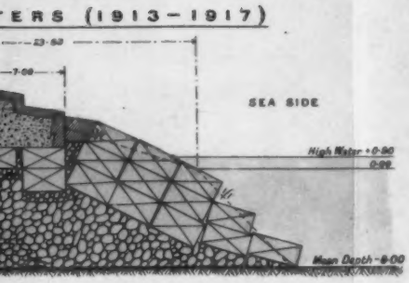
Scale for Sections.

1 METRE = 3·28 FEET



WARD & FOXLOW. Harcourt St. Marylebone, W.1. 5039.

TERS (1913–1917)



cks of 1 Ton.
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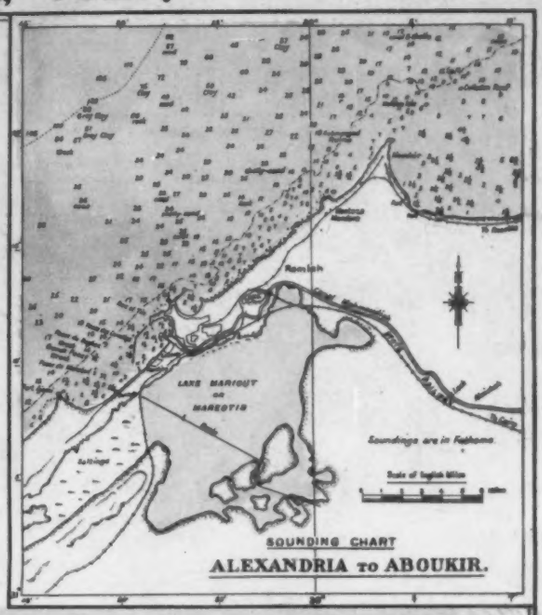
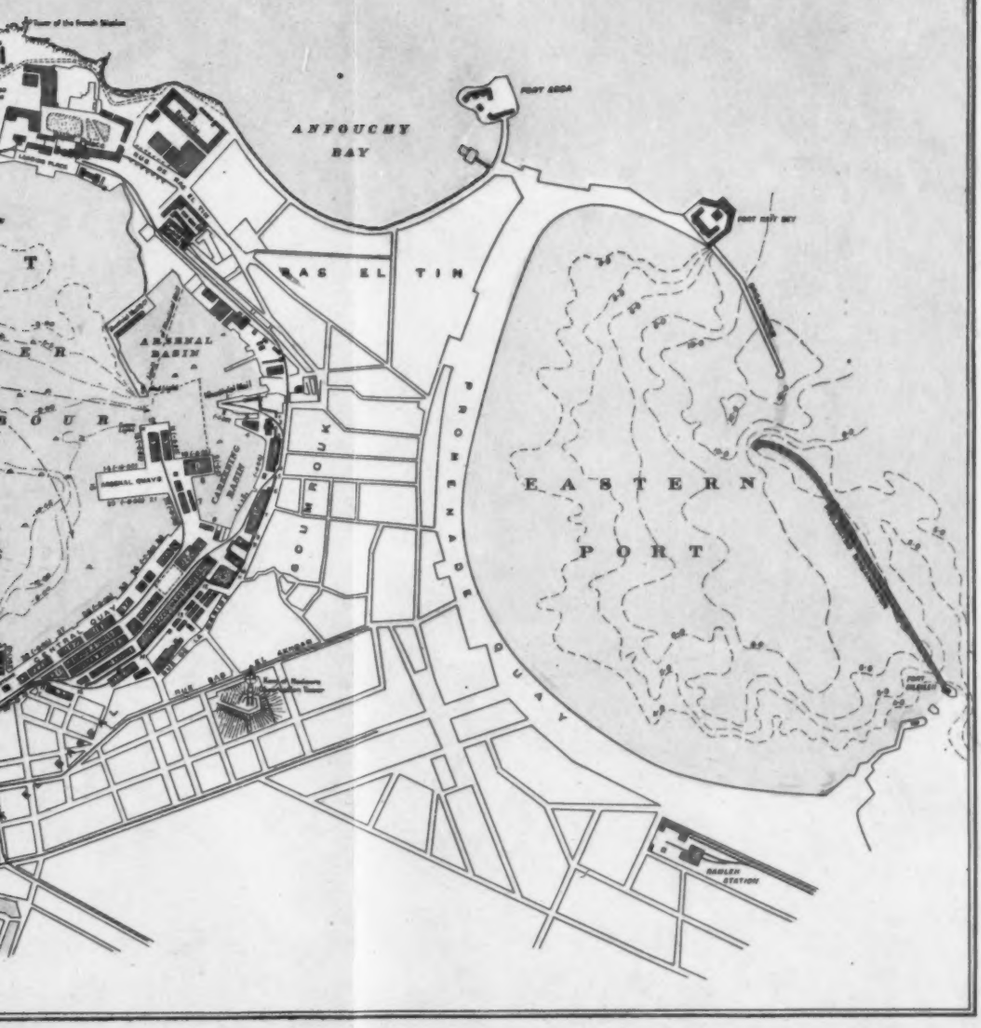
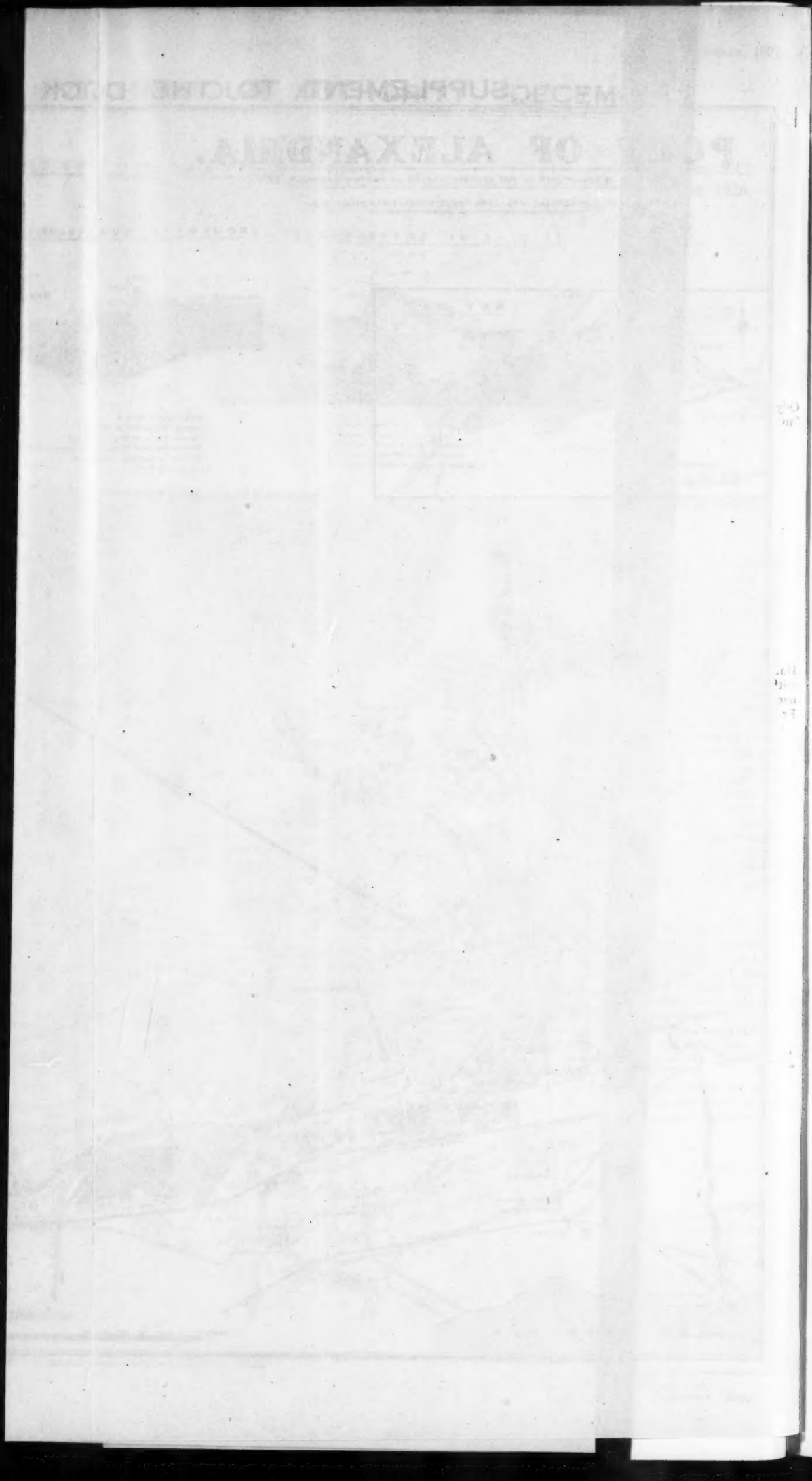
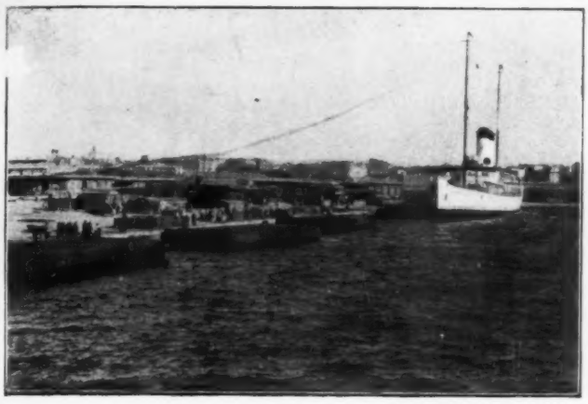


N S E A

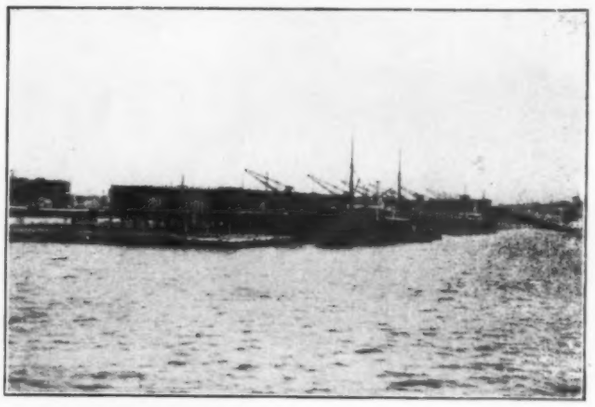
NOTE:– New Works are coloured RED.
Customs Hall & Gates shown
Contours are of Depths in Metres.







The Arsenal Quay, Inner Harbour, with breasting-off floats. This Quay accommodates the principal passenger services at Alexandria.



The New Mahmoudieh Quay-Pier. Note the open sides of the Transit Sheds on the first floor, although enclosed on the second floor. The Cranes are seldom used.

ssey. Menelaus speaking to Telemachus said: "That is-l .d has a great harbour. The gods kept me there twenty days."

There is considerable discussion concerning the authenticity of various harbour works of ancient times that have been discovered near Pharos Island (Ras El Tin). It is maintained that the ancient Ras El Tin breakwater is two kilometres long (1¼ mile) and 60 to 80 metres (200 ft. to 300 ft.) total width. Alexander the Great recognised the importance of the Port and improved the harbour. His works were followed by those of Ptolemy I. Soter, who constructed a causeway seven stadia long (about 1,300 metres, 4,290 ft.), the Heptastadia, built from the mainland over to Pharos Island. This Heptastadia caused the foundation of the present Ras El Tin peninsular through the gradual filling in of sand.

Ptolemy II. Philadelphus, as an aid to navigation had Sostratus of Cnide, erect a magnificent tower bearing fire at night at the eastern end of Pharos Island. At that time the East rbour was the more important. This lighthouse associated .n the name of the Island Pharos, has given the French ne Phare for all lighthouses, to this day, as for instance the ench Bureau of Lighthouses is called.

From antiquity, to Napoleon, the Port of Alexandria fell from glory and at the time of Napoleon's Egyptian campaign the population numbered hardly five thousand. During the rule of Mohamed Ali, this strong monarch began in 1835-40, the Arsenal Basin on the left side of the waist of the Ras El Tin peninsular.

The creation of the commercial port was begun in 1869, by Ismail and placed under an international commission. The principal work of this commission was the construction of a breakwater 2,340 metres (7,677 ft.) westward along the reef from Ras El Tin to the small island off Abbou Baka, and an interior jetty of 1,020 metres (3,347 ft.) forming a shelter for the inner port. The old breakwater was eventually extended to 2,900 metres (9,515 ft.) leaving an harbour area of approximately 750 hectare (1,853.25 acres) and 10 kilometres (6.2 miles) long, including the inner basin and 3 kilometres (1.92 miles) wide at the widest point.

The growth of the port with the rise of Egypt and the constant foreign market for Egyptian cotton made such demands on the facilities of the port that it was not long until the inner port or commercial basin had its capacity exceeded by this press of commerce. The old breakwater was widened to form a coal quay and then extended in an awkward arm to the left enclosing a coal basin. This particular form was necessary due to the fact that the main outer breakwater is too far away from the shipping and the waters in the outer harbour can become very choppy inside the breakwater. In the time when the harbour was built, sailing vessels that anchored in the roads needed room to manoeuvre; modern commerce is carried on in full powered steam or motor vessels. Now the breakwater could be brought in closer to shore because a distance of greater than 1 kilometre (⅝ of a mile) usually leaves sufficient room for a high wind to whip up a disagreeable choppy sea that might not be of damage to vessels riding at anchor but would interfere materially with vessels lying alongside quays taking on or discharging cargo.

To meet the increased traffic the nitrate wharf or the great modern lumber wharves to the west of the outer harbour have also been protected by an inner breakwater and as the port develops, it is to be expected that future contruction along the mainland and the outer harbour will require the construction of additional breakwaters close in to protect the quays.

The area of the Port both land and water and the lengths of the quays with the depths of water alongside are as follows:

Area of water in the inner harbour	240	hectares	...	593	acres
Area of water in the outer harbour	540	,,	...	1,434	,,
Total water area of the port ...	750	,,		1,863	,,
Land area	78.3	,,	...	193	,,
Length of quays accommodating vessels drawing 7 to 9.3 metres (22-ft. 11-in. to 30-ft. 6.in.)...	7,263	metres		23,829-ft.	
Length of quays with depth of 9.80 metres (30-ft. 6-in.)	1,218	,,		3,996-ft.	
Length of quays with depth of 9.00 metres (29-ft. 6-in.)	1,643	,,		5,391-ft.	
Length of quays with depth of 8.50 metres (27-ft. 11-in.)	253	,,		830-ft.	
Length of quays with depth of 8.00 metres (26-ft. 3-in.)	2,743	,,		8,999-ft.	
Length of quays with depth of 7.50 metres (24-ft- 7-in.)	501	,,		1,645-ft.	
Length of quays with depth of 7.00 metres (23-ft.)	905	,,		2,969-ft.	
Length of quays with less than 23-ft. alongside	3,802	,,		12,474-ft.	
Area of warehouses	126,000	sq. metres		1,356,264	sq. ft.

QUAYS AND WHARVES.

It must be emphasised here that Alexandria is one of the few Mediterranean ports where most of the vessels lie directly alongside well-equipped masonry quays. The practice in the large majority of Mediterranean ports is for vessels to lie moored fore and aft at right angles to the wharf and all goods or passengers are lightered or towed ashore. This is true of Port Said, Constantinople, Piraeus and even to a surprising extent at Marseilles.

Tracks paralleling the Central Quay in rear of Transit Sheds, with new Tobacco Warehouse in distance.

Cotton Export Warehouses and Compresses of the Egyptian Bonded Stores, Inc.

Harbour Engineering Notes.

ELECTRIC ARC WELDING.

Considerable developments have recently taken place in the application of electric welding, particularly in this country, and a noticeable feature of the recent Shipbuilding and Engineering Exhibition was the high standard achieved by the designers of welding sets, and the interest shown in them by visitors. Much work has been done in this country in the application of electric welding to heavy steel structures and plant, though gas welding is still very popular in America. Recently, however, the electric process has been used in the latter country in the erection of steel frame buildings in place of riveting.

There is little doubt that, compared with riveting, the electric welding process results in considerable saving, and even the most conservative designers are being converted to this fact. Where riveted construction is employed, the plate must be layed off from the templates and every rivet hole marked and centre punched before the plate reaches the machine shop. In the shop the holes are punched or drilled, the plate sheared, and then sent out for assembly in the finished structure. After the plate has been bolted in position, it is frequently found necessary to ream many of the holes before they can be filled with rivets. After driving, the rivets must be tested, and every rivet head and every inch of seam caulked to ensure watertightness.

By eliminating the routine of marking off, punching, reaming and caulking, to say nothing of the butt straps and insertions at watertight joints, there is ample margin to cover similar construction by means of electric welding until the process has become standardised, when costs will be still further reduced. With the welding method the plate is sheared to size, the edge being automatically bevelled by the rotary shear at the same time. A few holes for erecting bolts may be necessary, but otherwise the work is free from holes when delivered to the welder.

It is estimated that on the minor parts of a ship, welding involves a saving of at least 60 per cent. over riveting, and on the hull plating 25 per cent. Tests have shown that a riveted joint possesses 60 to 85 per cent. the strength of the original steel, and that welded joints have 80 to 100 per cent. strength.

The normal temperature of the metallic arc is approximately 3,300 deg. Cent., while that of the acetylene flame is approximately 2,500 deg. Cent. The minimum heat of the metallic arc has a high value, but the heat of the acetylene flame can be regulated down to a very small value. It follows, therefore, that for thin sheet metal work (less than $\frac{1}{8}$ in. thick), and for small cast iron work, the acetylene flame is cheaper and easier to apply than the electric arc. With acetylene welding, however, crystallisation, hardness and tensile strength of the welded metal depend on the purity and the proportion of the bases used, a fact which is often a source of trouble.

Welded sheet metal is lately rapidly superseding iron castings for such plant as tanks and boxes, where the metal is of thin cross section. A sheet metal tank is frequently made more quickly and cheaply than a cast iron tank, is lighter in weight, and practically unbreakable.

ELECTRICITY GENERATION BY DIESELS.

An interesting feature of the growing use of electricity for industrial and domestic purposes in Europe is the increasing number of Diesel engines which are being installed for generating this electricity. In consequence of their technical advantages, these engines are being found particularly suitable for use in central and private stations, either as independent machines generating the whole energy, or as a standby operating in conjunction with other sources of supply. The Diesel engine is becoming more and more indispensable as an auxiliary in large power stations. It can take the peak loads at a time when the demand on the station is greatest, operating, therefore, only a few hours at a time. It is, however, also capable of operating at full load and thus assisting to maintain the supply when a breakdown has occurred in other parts of the plant or when the demand for power continues to exceed the capacity of the main plant.

With regard to the size of the engines, it is possible to build them to comply with all requirements within wide limits. Certainly, they have not attained the huge outputs given by the largest modern steam turbines, but it is possible to construct single-acting Sulzer two-cycle Diesel engines in units developing up to 8000 B.H.P. each. There are, however, many plants requiring only medium sized engines, so that Diesel is consequently often adopted as a standby in hydro-electric and steam power plants.

Long experience in Europe has shown that the 1,000 KW unit is a size for which there are numerous opportunities for employment, and this is proved by the large number of units of this output which have been installed in central and private generating plants in Europe. In all, about 50 or so, 1,000 KW Sulzer Diesel plants are in regular operation in Europe for various purposes, for instance, lighting and tramways, public supply, steel works and radio transmitting stations in France; spinning mills and tramways in Russia; steel works, subways and public supply in Spain; public supply in Norway, Italy and Germany.

The great diversity of uses in which the 1,000 KW Diesel is employed must be regarded as evidence of the suitability of this type for supplying power under very severe conditions as regards closeness of governing and reliability of service.

There are many reasons for the increasing favour shown this size of Diesel. Medium-sized power stations find the 1,000 KW standby plant a unit large enough to supply any shortage due to a breakdown in the other sources of power and to take the peak loads. Large power stations instal two or more sets of this size, thereby enabling the total output to be graded so that the sets in service are operating approximately at full load and therefore at their highest efficiency. The dimensions of the set are such that it can always be kept under observation when running and can be easily attended by one man.

For lesser outputs, say up to about 300 B.H.P., an airless injection Diesel engine of very simple construction is proving very popular. In this engine, by combining the two-cycle process with a patented method of atomising the fuel without the aid of compressed air, a new type has been evolved which works on the Diesel principle and can hardly be excelled for simplicity of construction. The adoption of the two-cycle principle means the elimination of exhaust and air inlet valves with the valve gear.

Ignition in these engines takes place on the Diesel principle; that is to say, before fuel is admitted, the air in the cylinder is compressed to about 425-500 lb. per sq. in. and consequently attains a temperature at which the fuel ignites immediately on being injected. Fuel injection takes place gradually, the amount being automatically regulated at the fuel pump by the governor, corresponding to the load on the engine.

The fuel is injected under pressure through an automatic valve into a subsidiary chamber, the ignition chamber, which is in communication with the working cylinder and consequently filled with compressed air at a high temperature. A small portion of the fuel at once ignites, thus causing a certain rise of pressure and temperature. Owing to this pressure, the fuel subsequently injected into the ignition chamber is driven in a finely atomised state into the working cylinder, where combustion continues exactly as in a Diesel engine of the usual type, that is to say, without any sensible rise of pressure.

Two Diesel engines, each of 2000 B.H.P., have been installed at the central generating station, Berne, Switzerland. These engines have been used to take the peak loads, and such engines are typical of many being adopted throughout Europe.

GEAR GRINDING AND CUTTING MACHINES.

The problem of pinion grinding has been the subject of considerable investigation, the chief difficulty being the unavoidable wear on the grinding wheels, which causes a continuous deformation of the tooth profile. Various efforts have been made to offset the deformation by trueing up the grinding wheels from time to time, though it is often found that the deformation taking place between trueing up operations is sufficient seriously to affect the precision of the work.

These troubles have been overcome by a grinder designed on a new principle, which is being used on an increasing scale in this country for all classes of work. This grinder utilises the Maag principle, in which the grinding wheels are made in the form of slightly tapered saucer discs and cut with their inner edges only. Thus, the straight flanks of the generating rack tooth are represented by the projection of these inner edges, which naturally always lie in a plane, even when the edges wear out. This wear of the wheel, however, does not influence the shape of the generating flank at all, but only means a shifting of the working plane in the direction of the axis of the grinding wheel. The shifting of the grinding edge, which would cause the teeth ground later to be thicker than those ground previously, is automatically overcome by a special device which operates as soon as the slightest wear of the grinding edge has taken place, thus keeping it always in exactly the same position.

Where machines employing the Maag system are used, it is found that the smallest number of teeth can be cut without under-cut, and that the contact motion provides for a considerably greater degree of rolling motion than sliding motion, thus prolonging the life of the gear to a very appreciable extent. Entire freedom in regard to centre distances is allowable for each individual case as the Maag method makes it possible to cut any desired pitch without the need of special tools.

In the grinding machine the position of each cutting edge is automatically maintained to within 0.00004 in. by a feeler operating a solenoid and compensating screw. The two grinding discs are driven by their own motors, and are mounted on separate tables carried on a common slide so that the two cutting edges may be set to represent the tooth of a cutter of any pitch.

The gear to be ground is fixed on a horizontal slide and receives a reciprocating motion from a crank disc at the side of the machine, while the necessary rolling motion is provided by a pitch block and steel bands. Involute gears of any pitch circle within the capacity of the machine may be ground, nine pitch blocks only being required.

In addition to the involute generating motion, the work is also fed beneath the two grinding discs so that the teeth of gears of any face width may be ground. Dividing may be set to take place at either or both ends of the gear immediately the grinding discs are clear of the work, after which the table feed motion is reversed, both operations being automatic and controlled by adjustable stops. To secure accurate spacing of the gear teeth, the dividing plates have taper slots which are hardened and ground so that the error from any one tooth to an adjacent tooth does not exceed 0.0001 in. A gear box at the front of the machine provides four speeds for the reciprocating motion and four speeds for the feed.

In the cutting machine involute teeth of any standard or corrected tooth form may be produced, the machine working on the generating principle, using a rack type cutter. The cutter machine is of the vertical type, the work being supported on a horizontal table, and a pinion driving through two sets of change wheels on to the lead screw, worm and worm wheel, provides the required generating motion. The cutter slide is actuated by a crank pin and link and is balanced by a counterweight.

Nine cutting speeds are provided through hardened and ground gears enclosed in the body of the machine, and the feed is adjusted by varying the stroke of a pivoted lever. In addition to the lead screw, there is also a second quick-threaded screw driven by friction from a small gear mounted on the lead screw, the object of this being to keep the table nut locked between these two screws, thus automatically taking up backlash between the table nut and lead screw.

Means are provided for setting the cutter dead parallel to the work table slide. When generating teeth, the gear blanks may be rolled into the cutter from either end, thus allowing all teeth in the cutter to be used before resharpening becomes necessary. All motions during the quick reversing period are controlled by an automatic drum at the back of the machine.

Gears cut on the Maag system are at present in use on motor cars, motor lorries, machine tools, turbine reduction gears, electric locomotives and tramcars.

THE HELIX CLASSIFIER.

Introduced first to effect the separation of sand from slime in the cyanidation process, the helix classifier has, during the past few years, been adapted to a wide variety of chemical processes. This classifier consists of a trough enclosing a revolving helix. The trough is inclined at one end, where the slime is discharged, while at the upper end is a hopper for the sand. Revolving on a central axis in the trough is a spiral blade, which is single and continuous at the overflow end for part of the length, and double with interrupted flights for the rest of the trough. The spiral is gear-driven and revolves at from three to five revolutions per minute.

In operation, the pulp entering the feed box meets the slowly moving spiral, the heavier solids settle to the bottom of the trough and are gently advanced out of the surface of the bath toward the sand discharge end, the intermittent spiral permitting the contained moisture to flow back into the charge, the slow turning over of this sand washing the finest solids back and allowing the sand to dry with the exception of that moisture held by capillary attraction. The lighter solids suspended in the liquid flow over a weir into a collecting hopper.

A classifier of this type will give a close separation at 60, 80 or 100 mesh, but where a much finer slime has to be dealt with, a modification of this classifier, giving greater volume in the bath and increased length of the overflow weir, has proved very satisfactory.

AUTOMATIC SUB-STATIONS.

The increasing use of electricity in this country, whether from central generating or hydro-electric power stations, will inevitably involve a more widespread use of automatic sub-stations, and it is gratifying to note that British manufacturers of electrical equipment probably lead the world in the design and construction of plant for automatic sub-station operation. Automatic control gear is now being constructed in this country which not only performs all the operations of switching, starting up and shutting down electrical generators and converters—operations usually performed by skilled attendants in manually operated stations—but perform these operations more efficiently and with even greater reliability than prevails with the most carefully supervised manual equipment, in addition to which the automatic control gear provides full protection to the machinery and the load at all times. Every contingency is provided for and nothing is left to guesswork or to the judgment of an operator.

Up to the present time no operating condition has yet arisen which cannot be satisfactorily dealt with by automatic control gear. The machines in an automatic sub-station may be started up and put into service by any one of several methods, according to requirements. For instance, the machinery may be started up (1) when the load demand reaches a predetermined value, (2) by a manually-operated master control switch, situated in some distant control room, (3) by a time switch, (4) by closing a high tension feeder switch at the power station or at some other point, and (5) in the case of a hydro-electric station, by a float switch. When the machinery is started up automatically arrangements may be made so that an audible signal is given at a distant point so that the engineer in charge may know that the station has started up, and is operating satisfactorily. In other cases various audible alarms can be incorporated in the design of the station. In one coal mine, for instance, the automatic sub-station is started up by means of an automatic telephone installation, the controller dialling a certain number and the station corresponding to that number starts up. An audible signal is given by the station which is transmitted to the earpiece of the telephone receiver, so that the controller is advised that all is well.

There are a large number of technical advantages which commend the automatic station to electrical engineers, such as economical buildings, noiseless construction, economy in distribution, more economical running of machinery when the station is controlled by load demand, more uniform line pressure, complete protection against all abnormal conditions and the possibility of regeneration in the case of traction schemes in districts with long gradients. Automatic sub-stations have been successfully applied to traction, municipal power and lighting, mining, industrial power and lighting, hydro-electric supply, railway signal service, and battery charging.

PROTECTIVE THERMAL OVER-CURRENT RELAYS.

A new form of thermal relay has been developed as a protection for motors with the object of enabling the user to get the maximum continuous service from the machine without danger of injuring the insulation through over-heating. The usual forms of protection, viz., fuses and electro-magnetic relays, while affording protection against excessive overloads, cannot protect against prolonged overloads just above the normal rating of the motor. In other words, the thermal relay protects by temperature and not by pre-determined excess of current. It allows a motor to carry an overload to the limit of its heating capacity without unnecessary tripping.

A relay having such a characteristic is especially suitable for motors subjected to a variable load, such as on machine tool work. Brief overloads of 40 to 50 per cent. will not injure the motor if followed by a sufficient period of under-load or light running. It is practically impossible to pre-determine either the amount of overload or its duration, or the period of rest in such cases, so that time-lags and similar devices, in conjunction with electro-magnetic equipment, do not give the ideal protection. With the latter in use the motor may frequently be unnecessarily stopped on heavy overloads of short duration when the temperature of the machine is such that it could safely withstand such temporary loads.

Thermal over-current relays are also particularly adapted to those conditions where a high peak current is momentarily experienced when starting up, e.g., when switching a squirrel cage motor direct on to the line, or at starting and when switching over to " running " with two-position starters.

The device consists of a heating element, heated by the current in the motor circuit, a latch composed of B.T.H. thermostatic metal, which curves upwards when heated, contacts which may be connected in an under-voltage or contactor coil circuit, which open the circuit when released by the thermostatic strip, and mechanical means for re-setting the latch after operation on overload.

The thermostatic metal is a duplex metal prepared by the permanent union, or welding throughout their length, of two metals having widely different co-efficients of expansion. The varying rates of expansion or contraction of the two metals cause the whole strip to bend when heated. This reaction is always the same in a given strip, for a given temperature change, and therefore functions reliably. No current is carried by the strip.

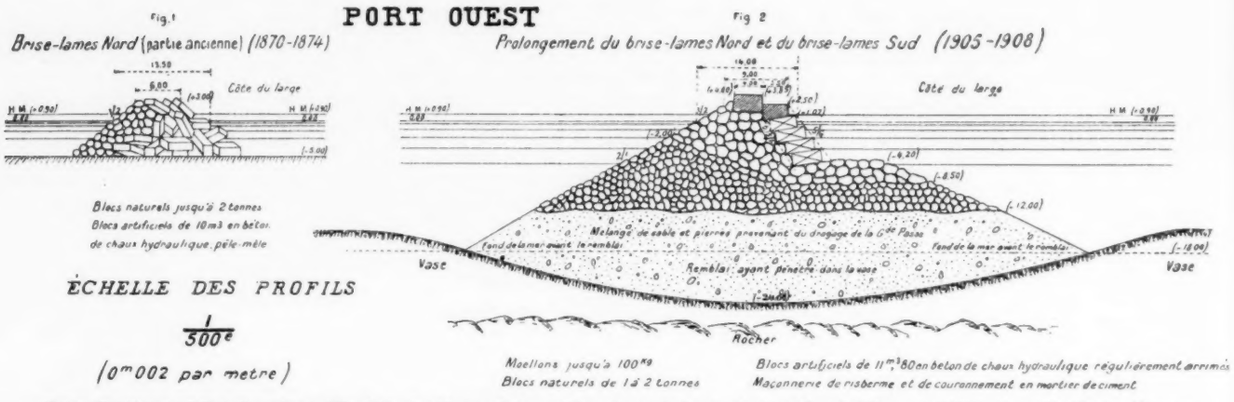
The device is intended primarily to protect the motor against ordinary working overloads, but not against severe electrical faults, such as short circuits. They will handle, satisfactorily, loads up to approximately ten times the full load current at which the relay is rated. There should, therefore, be in the feeder, or branch circuit, an instantaneous trip circuit breaker, set at not over ten times full load current, or fuses rate at not over five times that figure. After operation on overload the relays are usually re-set by hand. In special cases, where remote control is essential, an electro-magnetic re-setting device can be fitted.

NEW JAFFA WAREHOUSE.

A modern warehouse and Customs stores of 1,300 sq. metres floor area provided with electric goods lift and loading platforms is under construction at the Port of Jaffa, Palestine.

The Port of Alexandria.

By ROY S. MACELWEE, Commissioner of Port Development, City of Charleston, S.C. U.S. Delegate to the Fourteenth International Navigation Congress, Cairo, Egypt, 1926.



Cross Sections of Breakwaters, West Port, Alexandria, with acknowledgments to "Special Report," Monsieur M. E. Quellennec, 14th International Navigation Congress, Cairo.

THE Port of Alexandria, Egypt, the third in importance in the Mediterranean after Marseilles and Genoa, is the gateway for 95 to 99 per cent. of the flourishing commerce of Egypt and the Sudan. Its average annual turnover is about £100,000,000, divided in the ratio of about 60 per cent. exports, and 40 per cent. imports.

Alexandria is a thoroughly modern and well equipped commercial sea port where vessels drawing as much as 30 ft. lie alongside the quays to load or discharge.

HYDROGRAPHIC CONSIDERATIONS.

The old lighthouse on the western point of Ras El Tin is situated at 31 deg. 11 mins. 43 secs. north latitude and 29 deg. 51 mins. 40 secs. east longitude. This cylindrical tower, 55 metres (180 ft. 5 in.) in height was erected in 1844. The revolving light is prismatic with 24 faces, with a continuous flash *in toto*. The light is visible for 20 miles.

There are two approach channels: (1) One from the North West to South East called Boghaz Passe, is on the axes of the range lights shown by the Small Tower of Mex and the Great Lighthouse of Mex visible ten miles. The Boghaz has a width of 91.5 metres (300 ft.), depth of 9.15 metres (30 ft.) for a distance of 1,600 metres (1 mile), crossing the shallow water that parallels the coast. Through the channel **90 deg.** turn to port leads through the entrance into the outer harbour between lights at the end of both the jetties; green, right; red, left. Thence an almost straight course marked by light buoys passes through the outer harbour and anchorage into the inner of the commercial harbour.

(2) The main channel entrance, le Grande Passe, crosses the bar from approximately West by North on the range of lights of the Small Lighthouse of Mex (Petit Phare du Mex) and the Great Lighthouse of Mex (Grande Phare du Mex). It has a width of 183 metres (600 ft.); a depth of 10.66 metres (35 ft.) for a distance of 2,000 metres (1¼ mile). The inner end of the channel is marked by a light buoy, thence an easy turn of about 60 deg. to port brings the vessel into the main harbour channel, approximately parallel with the shore.

TRAFFIC.

Alexandria, showing little trace of its ancient history is a modern city of 500,000 population. It is connected with the Nile system by the inadequate Canal Mahmoudieh leading from the inner port, Basin of Commerce, to the West branch of the Nile called Rosette through the town of Fouah, a distance of 90 kilometers (56 miles). This canal has a depth of 2 metres 70 centimetres (8 ft. 10 in.) and a width varying from 25 to 40 metres (82 ft. 130 ft.) Its navigation is slow and difficult and is carried on in typical Nile sailing vessels towed by men in harness, à la Volga Boatman, assisted by the single graceful sails when a wind is favourable. This canal needs improvement to accommodate the press of traffic passing through it.

Railroad connection with Cairo, and with Port Said although round-about, is furnished by the State Railroads of Egypt. There are three stations in Alexandria; the Station of Ramleh for the East, the Cairo Station in the middle and the Galbari Station near the Canal Mahmoudieh to the West. These rail connections are extended on to most of the quays although not to the number and extent usually considered essential in modern port construction.

TAXES AND DUES.

The present tariff set by Treaty requires the Egyptian Government until 1930 to levy no duty on products of the soil or of industry in excess of 8 per cent. ad valorem, except upon alcoholic beverages not exceeding 50 per cent. of alcohol, which is taxed 10 per cent. ad valorem and 15 per cent. above 50 per cent. of alcohol. There is an export tax of one per cent. ad valorem on all exports of Egypt and an additional export quay dues of 12 per cent. on general mechandise.

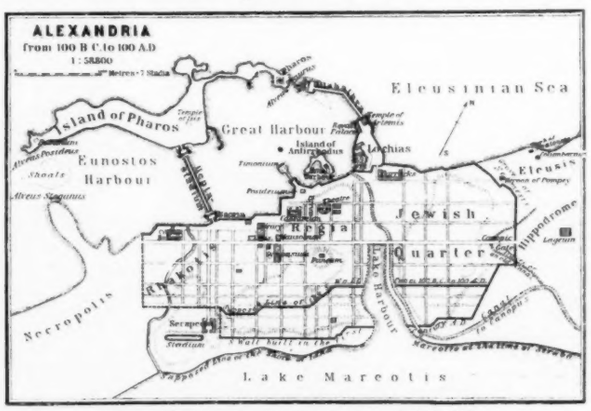
Importations and exportations are facilitated by two warehouse companies, the Bonded Store Company, Limited, with a reinforced concrete warehouse of 20,000 square metres (215,280 sq. ft.) and the Egyptian Bonded Warehouse Company, Limited, that also acts as agents, as custom house brokers, as forwarders, and issue warehouse certificates and warrants on goods stored in their warehouse.

The principal agents of the steamship lines and firms have their offices in Alexandria not only because of the concentration of the business of Egypt at this point, but also due to the fact that the seashore to the East of the City proper is a summer resort of Egypt where the wealthy merchants, cotton brokers, and pachas have their villas. One very large and extremely attractive hotel in particular, the Casino San Stefano, is the rendezvous of smart Egypt in summer as it is of the smart Europeans in the winter.

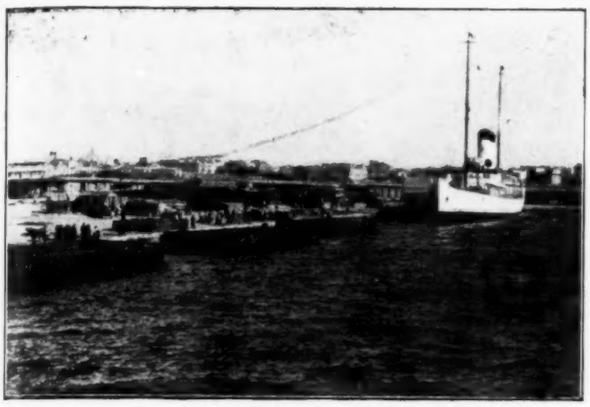
THE PORT OF ALEXANDRIA.

Alexandria is situated on a peninsula extending at right angles from a long low shore line separated from the mainland by Lake Maryut, a typical North African lagoon salt lake, of a depth of approximately 2 metres (6 ft. 7 in.) The peninsular Ras El Tin branches to the East to Fort Kait Bey and to the West to Point Ras El Tin. This Western branch afforded a natural shelter together with the continuation of the branch in the form of a bar or ridge extending to the Island Abbou Baka and other points for a distance of ten kilometres (6.2 miles). This isthmus is approximately 700 metres (2,297 ft.) wide and 3 kilometres (1.9 miles) long.

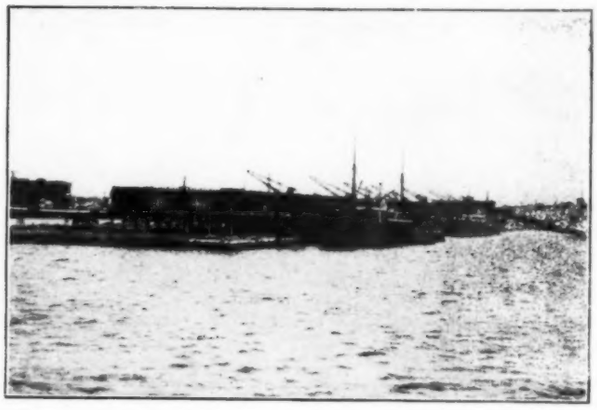
The same Pharos Island as it was formerly, it having filled in since, was mentioned by Homer in the Fourth Book of the



Alexandria, between 100 B.C. and 100 A.D.
[*Baedecker's "Egypt."*



The Arsenal Quay, Inner Harbour, with breasting-off floats. This Quay accommodates the principal passenger services at Alexandria.



The New Mahmoudieh Quay-Pier. Note the open sides of the Transit Sheds on the first floor, although enclosed on the second floor. The Cranes are seldom used.

Odyssey. Menelaus speaking to Telemachus said: "That island has a great harbour. The gods kept me there twenty days."

There is considerable discussion concerning the authenticity of various harbour works of ancient times that have been discovered near Pharos Island (Ras El Tin). It is maintained that the ancient Ras El Tin breakwater is two kilometres long (1¼ mile) and 60 to 80 metres (200 ft. to 300 ft.) total width. Alexander the Great recognised the importance of the Port and improved the harbour. His works were followed by those of Ptolemy I. Soter, who constructed a causeway seven stadia long (about 1,300 metres, 4,290 ft.), the Heptastadia, built from the mainland over to Pharos Island. This Heptastadia caused the foundation of the present Ras El Tin peninsular through the gradual filling in of sand.

Ptolemy II. Philadelphus, as an aid to navigation had Sostratus of Cnide, erect a magnificent tower bearing fire at night at the eastern end of Pharos Island. At that time the East Harbour was the more important. This lighthouse associated with the name of the Island Pharos, has given the French name Phare for all lighthouses, to this day, as for instance the French Bureau of Lighthouses is called.

From antiquity, to Napoleon, the Port of Alexandria fell from glory and at the time of Napoleon's Egyptian campaign the population numbered hardly five thousand. During the rule of Mohamed Ali, this strong monarch began in 1835-40, the Arsenal Basin on the left side of the waist of the Ras El Tin peninsular.

The creation of the commercial port was begun in 1869, by Ismail and placed under an international commission. The principal work of this commission was the construction of a breakwater 2,340 metres (7,677 ft.) westward along the reef from Ras El Tin to the small island off Abbou Baka, and an interior jetty of 1,020 metres (3,347 ft.) forming a shelter for the inner port. The old breakwater was eventually extended to 2,900 metres (9,515 ft.) leaving an harbour area of approximately 750 hectare (1,853.25 acres) and 10 kilometres (6.2 miles) long, including the inner basin and 3 kilometres (1.92 miles) wide at the widest point.

The growth of the port with the rise of Egypt and the constant foreign market for Egyptian cotton made such demands on the facilities of the port that it was not long until the inner port or commercial basin had its capacity exceeded by this press of commerce. The old breakwater was widened to form a coal quay and then extended in an awkward arm to the left enclosing a coal basin. This particular form was necessary due to the fact that the main outer breakwater is too far away from the shipping and the waters in the outer harbour can become very choppy inside the breakwater. In the time when the harbour was built, sailing vessels that anchored in the roads needed room to manoeuvre; modern commerce is carried on in full powered steam or motor vessels. Now the breakwater could be brought in closer to shore because a distance of greater than 1 kilometre (⅝ of a mile) usually leaves sufficient room for a high wind to whip up a disagreeable choppy sea that might not be of damage to vessels riding at anchor but would interfere materially with vessels lying alongside quays taking on or discharging cargo.

To meet the increased traffic the nitrate wharf or the great modern lumber wharves to the west of the outer harbour have also been protected by an inner breakwater and as the port develops, it is to be expected that future contruction along the mainland and the outer harbour will require the construction of additional breakwaters close in to protect the quays.

The area of the Port both land and water and the lengths of the quays with the depths of water alongside are as follows:

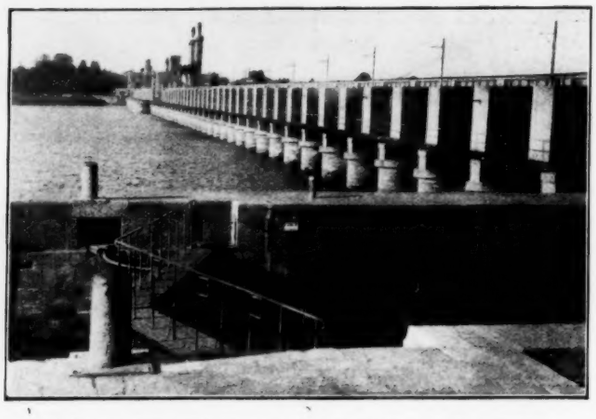
Area of water in the inner harbour	240	hectares	...	593	acres
Area of water in the outer harbour	540	,,	...	1,434	,,
Total water area of the port ...	750	,,		1,863	,,
Land area	78.3	,,	...	193	,,
Length of quays accommodating vessels drawing 7 to 9.3 metres (22-ft. 11-in. to 30-ft. 6-in.)...	7,268	metres		23,829-ft.	
Length of quays with depth of 9.30 metres (30-ft. 6-in.)	1,218	,,		3,996-ft.	
Length of quays with depth of 9.00 metres (29-ft. 6-in.)	1,643	,,		5,391-ft.	
Length of quays with depth of 8.50 metres (27-ft. 11-in.)	253	,,		830-ft.	
Length of quays with depth of 8.00 metres (26-ft. 3-in.)	2,743	,,		8,999-ft.	
Length of quays with depth of 7.50 metres (24-ft- 7-in.)	501	,,		1,645-ft.	
Length of quays with depth of 7.00 metres (23-ft.)	905	,,		2,969-ft.	
Length of quays with less than 23-ft. alongside...	3,802	,,		12,474-ft.	
Area of warehouses	126,000	sq. metres		1,356,264	sq. ft.

QUAYS AND WHARVES.

It must be emphasised here that Alexandria is one of the few Mediterranean ports where most of the vessels lie directly alongside well-equipped masonry quays. The practice in the large majority of Mediterranean ports is for vessels to lie moored fore and aft at right angles to the wharf and all goods or passengers are lightered or towed ashore. This is true of Port Said, Constantinople, Piraeus and even to a surprising extent at Marseilles.

Tracks paralleling the Central Quay in rear of Transit Sheds, with new Tobacco Warehouse in distance.

Cotton Export Warehouses and Compresses of the Egyptian Bonded Stores, Inc.



Locks for Nile Shipping at the Delta Dam below Cairo.

The Central Quay for General Merchandise, Inner Harbour.

The old Arsenal Basin is occupied largely by Government operations, such as the offices of the ports and lighthouses, the mechanical workshops and the quays of the Khedivial Mail Line.

The Arsenal Quays, of modern construction, a modern extension of the south jetty of the Arsenal Basin, is where the principal passenger and fast freight vessels discharge their cargo, such as the Lloyd Triestino, the Royal Rumanian Line and others. This quay is a substantial series of masonry quays, in the form of a Greek cross. There is one rail line entering the quay and some small transit sheds by the main quay. Berths 14, 15, 20 and 21 are open, that is, simply paved without sheds. This quay has a depth of 33 ft.

Quay Centrale, a marginal quay, skirting the South-east shore of the inner basin from the Quay de l'Arsenal to the Quay du Mahmoudieh, with depths of 24 to 28 ft., is the principal cotton exporting quay. It is supported by transit sheds and the great warehouse of the Egyptian Bonded Stores Inc. This quay is also paralleled by tobacco warehouses and those for general merchandise.

The new quay-pier, the Quay du Mahmoudieh, with 33 ft. of water alongside parallel the entrance to the Mahmoudieh Canal, from which it takes its name. It is completely modern in construction. The East quay of this pier is open, without shed. The West quay carries two modern two-storey transit sheds, each one served by four electric cranes. These transit sheds of stool, brick and masonry construction are unusual in that the first floor or main quay deck level has no side walls, while the second deck is closed in the customary manner with a wide landing ledge upon which the cranes deposit the merchandise.

It is interesting that the attempt to use electric cranes on this pier, the first to be equipped with electric cranes in the Port of Alexandria, has been unsuccessful, due to the personal element. The crane dues are usually divided between the master and the stevedore, and the master works the ship's winches and the stevedore breaks out or stows the vessel in the usual ship's winch method. There is no law to enforce the use of the cranes and they, therefore, serve as an ornament to this splendid modern pier. This opposition to the use of cranes is found at many newer ports for years accustomed to using ship's winches only.

The Coal Quay, Quay à Charbons, has a small spur quay pier for general merchandise, otherwise the entire pier is equipped with coal bridges for the rapid handling of the fuel to and from the stock pile.

In the inner harbour along all of these quays used for general merchandise the unusual system of breasting the vessel off from the pier by means of wide stout wooden lighters or pontoons is striking. All passengers and merchandise are landed from the ship on to these pontoons and are run ashore from there.

There are important port structures in the outer harbour. (1) The first equipment to the south-west of the Quay à Charbons is the Quay des Inflamables, a petroleum products harbour section with five small piers and a tank farm.

(2) The great lumber terminal quay, Quay a Bois, near the entrance to the outer port. This terminal consists of three wide quay-piers and an upland of huge hangars almost resembling a shipyard, equipped with the most modern lifting and transporting machinery. At the present time the most of this elaborate modern equipment lies idle because the owner was so successful in his lumber operations during the War that he has retired from business and written off the investment in this equipment.

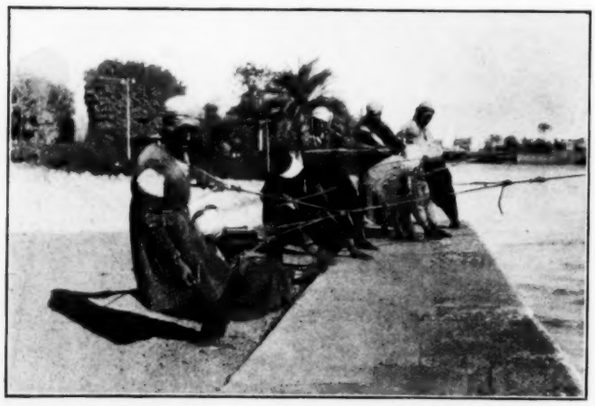
Westward from the Quay a Bois are (3) the Quay a Nitrates and (4) the Quay de la Quarantaine.

The entire port proper of Alexandria is enclosed by a high wall and stockade carefully guarded by harbour police as in a free port.

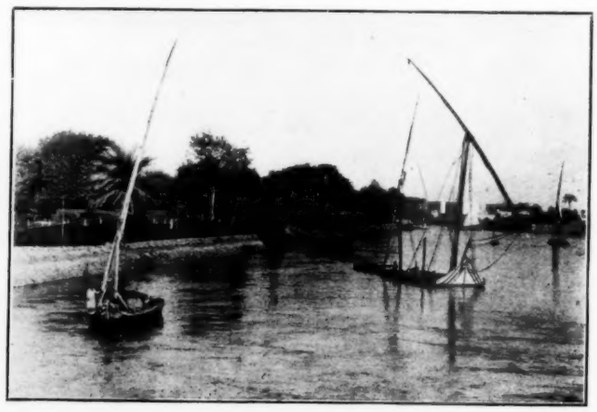
These harbour police deserve special mention. They are largely native Egyptian, that is Arab stock, with some English officers. They are immaculate in the appearance of their perfectly-fitting uniforms and most soldierly and snappy in their bearing. The Department of Ports and Lighthouses of Egypt is under Captain Philip Streatfield Pacha, Royal Navy, with a staff also largely native Egyptian. The entire appearance of the well-kept port, its snappy police, and its modern construction is in conformity with the modern spirit of progress abroad in Egypt—a spirit that carries with it a danger that the Egyptians may become so nationally self-conscious that they stub their toe on the British protection of the Suez Canal stone. However, Captain Streatfield's staff is also the high office in the Ministry of Communications of Cairo, and are enterprising and progressive young Egyptians, alert and ambitious. In fact, the quay Mahmoudieh was designed by Samy Pasha, an engineer, at present Egyptian Minister in Washington, while Under Secretary of Public Works.

CITY WATERFRONT BOULEVARD IMPROVEMENT.

A further word may be added concerning the East Harbour. This is a shallow bay receiving little protection from Fort Kait Bey, and a comparatively short breakwater that has been added in the general easterly direction. Alexandria has used the East Bay frontage of the city for recreation and constructed a quay promenade along its crescent shore. However, in periods of high winds, the seas dash over the quay promenade to such an extent that a breakwater is now projected to close the bay making it available for the anchorage of yachts and fishing vessels of comparatively slight draft.



Nile Boatmen who operate from Alexandria through the Mahmoudieh Canal at the Delta Dam below Cairo.



Types of Nile Boats that distribute freight from Alexandria through the Valley of the Nile.

Warehouses at the Port of Alexandria.

By continuation of the East shore line from this promenade is formed the Atlantic City beach of Egypt. This quay promenade and drive also forks to the West near Fort Adda along the shallow Bay d'Anfouchy across the end of the Ras El Tin peninsula past the barracks and the rear of the Royal Palace, the summer residence of King Fuad, to the Royal Egyptian Yacht Club near the great beacon Ras El Tin. This yacht club faces the sea on the one side and the Bay on the other, a delightful location. The King spends much of his time at his summer palace.

ENGINEERING FEATURES.

The engineering features of importance are the breakwaters that enclose the west and east ports of Alexandria. These are fully discussed in the paper by Mr. E. Quellennec, former Chief Engineer of the Suez Canal Company and Consulting Engineer of the municipality of Alexandria, in his paper No. 31, submitted to the XIV. International Navigation Congress at Cairo, 1926. The cross sections of these breakwaters require very little explanation. The old breakwater (Fig. 1), built in 1870-74 was unnecessarily expensive, due to the system employed: artificial blocks of 10 cu. metres (353 cu. ft.), dumped at random with natural rock in sizes up to 2 tons also dumped at random.

The extension of the breakwater into deeper water, the harbour works of 1905-08 (Fig. 2), Mr. Quellennec consulting engineer, utilised the dredge spoil from dredging the anchorage, sand and gravel, to form a ridge as a bed for the breakwater up to minus 12 metres. On this base was dumped rubble up to 220 pounds (100 kg.). The ocean side from minus 420 m. to + 1.07 m. was built up on a slope of 5 to 6 with four courses of artificial concrete blocks of 11.8 cu. metres (419 cu. ft.) (24 tons), deposited regularly, but tilted 15 per cent. towards the interior of the mound. Each higher course of the four courses up to + 1.07 is set back to make an incline of 5 to 6. This has three qualities, stability in case of settling, weighing of the lower courses by those above and the footwalk crown and the tendency of waves to force the blocks harder against the cove and not lift them loose. From + 1.07 to + 2.50 a concrete cap was added to + 2.50 and then an interior crown of concrete to +3.85. The harbour side of the breakwater of rubble and stone of boulders of 1 to 2 tons on a slope of 2 to 1 and then 3 to 2. Although of a much greater cross section and content, this breakwater was not more expensive than the old one, yet it showed greater stability.

A similar system was followed in the works of 1905-08 (Fig. 2) in the quay driveway of the East port and a very solid and ingenious breakwater section is now under construction. In this case the artificial concrete blocks of 22 cu. metres (777 cu. ft.) (44 tons) are tilted toward the force of the waves rather than away, as in Fig. 2. On a slope of 1/1, or 3/1 and capped by a concrete and masonry crown, they have a tendency to be forced down into place after the impact of the waves rather than being lifted and dislodged. This newest breakwater is being constructed at a cost of about 5,600 gold francs (1,100 dollars) a running metre, or ($370 a foot). The breakwater extension (Fig. 2) cost about 5,000 gold francs a metre ($1,000 or $335 a foot), in 1905-08 before the increase in prices.

The Port of Alexandria may be ranked as one of the safest, best laid out and best equipped ports on the Mediterranean, and rates first-class among the best ports of the world.

BARROW DOCKS DISCHARGING.

A notable discharging feat has just been accomplished at the above docks by the L.M.S. Railway. The ss. *Laguna* with 2,000 tons of nitrate of soda arrived at Barrow Docks on the a.m. tide of 10th November, was berthed at 12.30 p.m. the same day and commenced unloading at 1 o'clock. 993 tons of nitrate of soda were taken from the steamer on that day and 1,007 tons on the 11th, the vessel leaving Barrow on the p.m. tide of November 12th

The Growth in Dimensions of Ships and its Bearing on Ports.*

By J. F. RAMSBOTHAM, M.Inst.C.E., M.Am Soc.C.E.

The navigable depths of rivers, harbours, and docks has of late years caused no small anxiety not only to shipowners, but also to those responsible for the administration of ports all over the world. The latter anxiety was made manifest in no small way by a proposal made at the 12th Congress of the Permanent International Association of Navigation Congresses, held at Philadelphia in the year 1912. The proposal reads as follows:—

1. It is desirable that a limit be set to the draught of sea-going vessels.
2. Government aid should not be extended to the building or operation of sea-going vessels whose draught exceeds 9.5 metres (32.2 ft.)
3. There should be an international agreement fixing the maximum dimensions of sea-going vessels built or operated under Government subvention, and there are tentatively suggested the following:

   Length over all ... ... 900 feet (275 metres)
   Breadth ... ... 105 feet (32 metres)
   Draught ... ... 32.2 feet (9.5 metres)

4. Any maritime canal which has locks with a usable length of 1,000 feet (305 metres) a width of 110 feet (33.6 metres) and a depth of water on the sill of 35 feet (10.7 metres) will fulfil every reasonable requirement of commerce.
5. In a maritime canal a wet section five times as large as the immersed portion of the largest ship which is to use the canal is desirable, as also a depth of one metre under the keel; but these values are functions of the speed at which the canal is to be navigated, and therefore to some extent also of the volume of commerce, and are to be determined by local conditions.

Of these proposals conclusion No. 5 only was adopted by the Congress, the remainder being rejected.

To the author it seems obvious that no restrictions should be put on private enterprise, and if economy can be shown in running vessels even in excess of the leviathans of to-day then it is assured (provided Naval Architects can design such vessels) that they will be built and run for the benefit of mankind. This fact once admitted raises the question of the depths of the harbours, bars, rivers, canals and ports all over the world, and any port which neglects its duty in providing the necessary depth of water will rapidly not only lose ground with its competitors, but become a decadent port. In Australia, perhaps unfortunately, the main ports of the States have no competitors, and consequently there may be a temptation to evade this burden of heavy expenditure, but if this is done the result must be a rise in freights, as some ports more favourably blessed by Providence in this respect will comply with the demands of shipowners, and the result may be that one central port will be selected and it will then become a distributing port for the Continent. If this double handling transpires then the second handling of goods will tend towards raising the price of commodities, both of imports and exports; and the resultant increase will be considerably in excess of any saving shown by way of neglecting to provide the requisite depths as laid down by shipowners.

The author proposes to divide the paper into two sections, viz.:—(1) The possibility of increased size of vessels trading with Australasia. (2) Their influence (mammoth vessels) on Australian ports as compared with British Ports.

THE POSSIBILITY OF INCREASED SIZE OF VESSELS TRADING WITH AUSTRALASIA.

To the author the problem of the "big ship" resolves itself into three issues, viz.:—

(a) The possibility of Naval Architects successfully continuing to design and evolve vessels of larger dimensions.
(b) The probability of shipowners placing further orders for such vessels of increased dimensions in the future.
(c) The popularity of such vessels with the general public.

Taking (a)—The possibility of Naval Architects successfully continuing to design and evolve vessels of larger dimensions.

There has been much speculation as to whether or not the limit has been reached by Naval Architects in designing mammoth vessels. It is purely a question for experts, and the author advises the views of the late Sir William White, K.C.B., F.R.S., D.Sc., LL.D., D. Eng., an expert of proved ability, formerly chief constructor to the British Navy, and *inter alia* associated with the design of the Cunard ship *Mauretania*. Sir William White, in a paper entitled "The maximum dimensions of Ships," read before the American Society of Naval

*Reprinted from the "Transactions" of the Liverpool Society by permission of the Council of the Society.

Architects and Marine Engineers, treated this subject most exhaustively. The author proposes simply to quote the conclusions arrived at by the writer of the paper:—

"Naval Architects will agree that, provided the money is "forthcoming for building still larger ships, their construction "will be possible, and that considerable increased dimensions "will present no serious difficulties, even if the materials for "shipbuilding already available were not improved upon. "Before iron was substituted for wood as the principal material "for shipbuilding, there was a period—within the recollection "of the writer and many of his professional brethren who are "still actively at work—when an upper limit of size and engine "power seemed to have been reached in wood-hulled ships. "Since that date Metallurgists have made great advances, and "progress is still being made, and on this side there is no bar "to immediate and considerable increase in the dimensions "of ships. The margin of possibility indeed appears to go far "beyond any probable demand."

The author ventures to think the meeting will agree that provided the capital is found and public demand is demonstrated Naval Architects will and can design vessels of greater size than any as yet built or on the stocks.

The following table of maximum dimensions of commercial steamers is given:—

Year.	Gross Tonnage.	Length. Ft.	Width. Ft.	Depth. Ft.	Depth. Ins.
1848	1,133	250	30	21	—
1873	5,349	411	48	23	—
1880	5,490	488	50	24	—
1885	8,144	566	52	29	10
1890	10,499	566	63	30	10
1895	12,952	601	65	30	9
1900	14,349	627	68	32	5
1905	24,000	708	75.5	38	—
1910	50,000	885	96	38	7
1915	51,969	882.9	98.3	57	1½
1920	54,282	907.6	100.3	58	2½
1925	56,551	915.5	100.3	58	3⅜

The above table would seem to indicate that a check is being experienced in building ships of large dimensions. Possibly the cost of any further material increase in size is not compensated by the earning capacity of such vessels.

(b) The probability of shipowners placing further orders for such vessels of increased dimensions in the future.

Shipowners are not philanthropists to the general public for nothing, and it is unquestionably to the benefit of mankind that large vessels should be built with their compensating facilities, comforts and increased speeds.

The factors that have contributed to the building of mammoth ships are keen competition among shipowners, demand for such vessels by the public, and the realisation of shipowners by experience that large vessels show an economy as compared with vessels of a smaller tonnage. At the same time it must be realised that the expense of running and maintaining mammoth vessels is considerable, and only possible when adequate means and facilities are provided for the quick and cheap handling of cargo at terminal ports and ports of call. As a matter of interest the following list of the cargo carried by ss. *Milwaukee* is given, and when it is remembered that this cargo was discharged in 66 working hours and represented 11,100 tons dead weight, there will be realised the necessity for not only facilities such as cranes and transporters but also shed accommodation (three-storey sheds) alongside the steamer, and in addition good facilities for vehicles and railway sidings, etc. The list of cargo is as follows:—

514 head of cattle	200 boxes of starch
132 horses	189,200 bushels of corn
640 sheep	20,025 boxes of cheese
18,412 bushels of oats	395 cases of apples
1,209 bales of hay	11 cases of machinery
13,149 sacks of flour	16,737 deal ends
51,629 pieces of deal	5,723 pieces of birch plank
16,328 boards	134 radiators
4,398 pieces of lumber	830 pails of lard
195 tierces of lard	5,730 boxes of grape sugar

Again, if the list of cargo given be studied, and if it be remembered that a vessel such as the Cunard Liner R.M.S. *Mauretania* carries a crew of 800 it will be realized how disastrous it must be for a ship of that type to be held up by a strike over some trivial matter. Strikes are by no means confined to Australia, but their possibility if anything acts adversely to the provision of large vessels, more particularly as there are five ports of call in Australia which contribute to the freight of a liner trading with this country, and each port must add to the anxieties of a shipowner.

In the Atlantic service it may be said that there are only two ports to contend with, each a terminal port, one in Europe, and the other in the United States, there being direct services from Eurcpe to both New York and Boston. The direct service to these ports was brought about by legislation in the United States which has helped to build up a considerable coastal trade in that country, and it is quite conceivable that what has been experienced in the United States may in time be experienced in Australia. At the present time, Sydney and Hobart are the only ports which can accommodate such vessels, and if, as already mentioned, a policy of centralization is adopted, such procedure will tend to a considerable rise in the cost of goods, due to a second handling, which whilst benefitting the coastal trade will adversely affect the community in general. At the present time there is nothing to tempt the shipowner to order mammoth steamers so far as Australia is concerned, the available depths of water at all ports, except Sydney and Hobart, being limited. The mechanical facilities for the economical handling of cargo are at a good many ports, crude, indifferent, limited, and in some cases, non-existent. The author has seen all the main ports in Australia, and in addition most of the minor ports, and it has been a puzzle to him to determine the reason for such indifferent ports. All the capital cities of the States are without exception fine cities, giving every evidence of considerable wealth and great forethought in conception and execution; yet although Providence has been generous in providing facilities for harbours the ports are lacking in those qualities which tend to the economical working of vessels. The very fact that all trucking is done on a rough worn timber deck must collectively cost the country many thousands a year, as it restricts the output per man, and necessitates the employment of additional men in order to maintain the output of work. The only reason that the author can advance for this are the following:—

In the first instance a considerable amount of caution was exercised, as the back country was not proved and the tendency was perhaps naturally to invest the major portion of available money in opening up the country, and as excellent timber was found, to use it for harbour construction, thus spending the money in Australia, and at the same time building the cheapest type of wharf, i.e., timber quays. This policy to the author's mind is correct only up to a point, and if extended beyond that point reacts on the community at large. In other words, the moment that a zone of country which serves a port is established, then the policy must be to drop the temporary expedient and supply permanent works, not neglecting to be liberal in making available an adequate depth of water for vessels. This policy has been adopted in Tasmania, and the excellent work done at Fremantle, Melbourne, Sydney, and on the Brisbane River is an object lesson to any Harbour Engineer; and it is to be hoped that the policy initiated will be maintained in the establishment of their future port on the Brisbane River.

The author would briefly sum up this section of his paper by saying that the inducements to shipowners to construct vessels of larger tonnage trading with Australia are:—

(a) The introduction of the Transcontinental Railway has tended to speed up the delivery of mails between the Eastern States of Australia and Europe, and also considerably shortened the sea voyage for passengers from those States.

(b) The influx of population must considerably increase the wealth of Australia.

(c) The development of Australia, assisted by immigration, will lead to increased trade and general prosperity, which in turn will seek an outlet from main ports.

It is quite beyond the scope of this paper to discuss the material worth and value of Australia and its trade, and the author confines himself to giving a Table as given by the Official Year Book, Commonwealth of Australia, No. 18, 1925.

Estimated Value of Commonwealth Produce, 1924.

Agriculture	£81,125,000
Pastoral Industry	102,843,000
Dairy and Poultry Farming	42,112,000
Forest and Fisheries	11,866,000
Mining	22,232,000
Manufacturing	132,392,000
	£392,570,000

After studying these figures, and remembering that six million people produce this wealth, and consequently that the Commonwealth is in its infancy as regards development, it will be admitted that everything points to the probablity of increased size of tonnage being built for shipowners trading with Australia, provided reasonable facilities are given for the rapid handling of cargo.

(c) The popularity of such vessels with the general public. The *Leviathan* is attractive to the business man and the bad sailor. The former is generally in a hurry, and the latter requires the minimum amount of "motion" or he suffers from *mal de mer*. Consequently there is a very large and influential proportion of the general public which demands this large type of vessel, and in addition in Australia there is a demand for a quicker transit to Europe both for mails and passengers. In addition, the safety appliances of the present day make the navigation of great steamships much safer than formerly. Wireless telegraphy, submarine signalling, and a constant increase in aids to navigation such as are seen in lightships, buoys, and lighthouses, have done much to remove former dangers to navigators.

(*To be continued*).